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RESEARCH MEMORANDUM

AN INVESTIGATION AT HIGH SUBSONIC
SPEEDS OF THE EFFECTS OF HORIZONTAL-TAIL HEIGHT ON THE
AERODYNAMIC AND LOADING CHARACTERISTICS IN SIDESLIP ON
A 45° SWEPTBACK, UNTAPERED TAIL ASSEMBLY AS DETERMINED
FROM FORCE TESTS AND INTEGRATED
VERTICAL-TAIL SPAN LOADINGS

By Harleth G. Wiley and William C. Moseley, Jr.

Langley Aeronautical Laboratory
Langley Field, Va.

CLASSIFIED DOCUMENT

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**NATIONAL ADVISORY COMMITTEE
FOR AERONAUTICS**

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SUMMARY

An investigation was made in the Langley high-speed 7- by 10-foot tunnel of the effects at high subsonic speeds of horizontal-tail height on the aerodynamic and loading characteristics in sideslip of a 45° swept-back, untapered tail assembly. Aspect ratios of the vertical and horizontal surfaces were 2.0 and 4.0, respectively. Configurations investigated were the fuselage alone and the fuselage plus vertical tail alone and with a horizontal tail mounted at 0, 50, and 100 percent vertical-tail span. Results were determined experimentally by force and moment tests on the complete tail assemblies and by pressure surveys of the loadings on the vertical tail.

Results indicated that the variations of the lateral-force and rolling-moment coefficients with sideslip at angles of attack of 0° and 4° were linear at sideslip angles less than about 8° for all tail configurations, with a pronounced decrease in the variations of the two characteristics at the higher sideslip angles. The value of lateral-force coefficient obtained at a sideslip angle of 4° at an angle of attack of 0° was increased by the end-plate effect of the horizontal tail when mounted at the extreme ends of the vertical tail. Rolling-moment coefficient for the complete tail assemblies increased with increase of horizontal-tail height at an angle of attack of 0°. The variations of lateral-force coefficient and rolling-moment coefficient with sideslip angle, expressed as slopes measured near a sideslip angle of 0° as determined from force tests, integrated vertical-tail loadings, and calculated loadings on the tail assemblies were in fair agreement and generally increased with Mach number.

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INTRODUCTION

Lateral-stability considerations for high-speed airplane designs have resulted in horizontal-tail locations for various airplanes ranging from a point on or below the fuselage center line to locations at the tip of the vertical tail. The National Advisory Committee for Aeronautics has undertaken an investigation at high subsonic speeds to determine the loads on a 45° sweptback, untapered vertical tail in sideslip as affected by the vertical location of a 45° sweptback, untapered horizontal tail. Pressure distributions on the vertical tail for three horizontal-tail locations are presented in references 1 and 2.

In order to extend the scope of the investigations and to effect comparisons with the results of the pressure tests and of existing theoretical methods, the present investigation of the effect of horizontal-tail height on the aerodynamic forces and moments of the 45° sweptback, untapered tail assembly was made. Tests were made with the fuselage alone and with the fuselage and vertical tail alone and with the horizontal tail mounted at 0, 50, and 100 percent vertical-tail span. Aspect ratios of the vertical and horizontal tail were 2.0 and 4.0, respectively, and an NACA 65A010 airfoil, measured perpendicular to the leading edge, was used for both surfaces.

Tests were made in the Langley high-speed 7- by 10-foot tunnel at angles of attack of 0° and 4° through a nominal sideslip-angle range of -2° to 23° where possible and over a Mach number range of 0.60 to 0.95. Reynolds number for the tests, based on the mean aerodynamic chord of the vertical tail, varied from about 1.9×10^6 to 2.4×10^6 .

Results of the tests are compared with the results of the pressure studies of references 1 and 2 and with the theory of references 3 and 4.

COEFFICIENTS AND SYMBOLS

The data presented herein are in the form of standard NACA coefficients of forces and moments based on vertical-tail geometry and referred to the body system of axes with the origin coinciding with the intersection of the fuselage center line and the quarter chord of the vertical-tail mean aerodynamic chord (fig. 1).

Coefficients and symbols used are defined as follows:

c_N normal-force coefficient, $\frac{\text{Normal force } N}{qS}$

c_X longitudinal-force coefficient, $\frac{\text{Longitudinal force } X}{qS}$

c_m pitching-moment coefficient, $\frac{\text{Pitching moment about } 0.25\bar{c}}{qS\bar{c}}$

c_l rolling-moment coefficient,
 $\frac{\text{Rolling moment about fuselage center line}}{qSb_v}$

c_n yawing-moment coefficient, $\frac{\text{Yawing moment about } 0.25\bar{c}}{qS\bar{c}}$

c_Y lateral-force coefficient, $\frac{\text{Lateral force } Y}{qS}$

c_n section normal-force coefficient of vertical tail as determined
by pressure tests of references 1 and 2

$$\Delta c_l = c_l - c_{l(\beta=0)}$$

$$\Delta c_Y = c_Y - c_{Y(\beta=0)}$$

P local pressure coefficient, $\frac{p_l - p_o}{q}$

V free-stream air velocity, fps

ρ mass density of air, slugs/cu ft

q free-stream dynamic pressure, $\rho V^2/2$, lb/sq ft

M Mach number

R Reynolds number based on mean aerodynamic chord of
vertical tail

p_l local static pressure, lb/sq ft
 p_0 free-stream static pressure, lb/sq ft
 S area of vertical tail to fuselage center line, sq ft
 b_v vertical-tail span from fuselage center line to tail tip, ft
 b' exposed local span segment of vertical tail, ft
 l distance from fuselage to center of b' , ft
 c local chord of vertical tail, ft
 \bar{c} mean aerodynamic chord of vertical tail, ft
 x longitudinal distance, ft
 z height above fuselage center line, in.
 h horizontal-tail height above fuselage center line, ft
 h/b_v ratio of horizontal-tail height to vertical-tail span
 α angle of attack, deg
 β angle of sideslip, deg
 $C_{l\beta} = \frac{\partial C_l}{\partial \beta}$
 $C_{Y\beta} = \frac{\partial C_Y}{\partial \beta}$
}
 (all slopes taken at $\alpha = 0^\circ$ through
 a linear range near $\beta = 0^\circ$)

Subscripts:

h horizontal tail
 v vertical tail

MODELS AND APPARATUS

Sketches and dimensions of the models used in this investigation are presented in figure 2, and a representative photograph of one of the models

mounted in the wind tunnel is presented as figure 3. (The models used are the same as those used in the pressure-survey tests of refs. 1 and 2.) The tail surfaces were fabricated of welded steel cores with glass cloth and transparent plastic finish contours. The vertical and horizontal tails had NACA 65A010 airfoils normal to the leading edge, were of untapered plan form with 45° sweepback, and had aspect ratios of 2.0 and 4.0, respectively. The tail surfaces were mounted on a cylindrical body fabricated of sheet aluminum with an ogival-shaped nosepiece (figs. 2 and 3).

Configurations tested included the fuselage alone, fuselage plus vertical tail, and fuselage plus vertical tail with the horizontal tail mounted at 0, 50, and 100 percent vertical-tail span with the quarter chords of the vertical and horizontal surfaces coincident at the intersection of the two surfaces. The tail assemblies with the horizontal tail located at $0.5b_v$ and $1.0b_v$, respectively, were mounted on the fuselage 1 vertical-tail chord ahead of the location for the vertical tail with horizontal tail at Ob_v in order to maintain aerodynamic pitching moments within the design load limits of the tunnel balance system (fig. 2).

The tail assemblies were mounted on a six-component electrical strain-gage balance attached to the sting support system of the Langley high-speed 7- by 10-foot tunnel with the vertical surfaces mounted in the horizontal plane (fig. 3).

TESTS AND CORRECTIONS

The tests were made through a Mach number range of 0.60 to 0.95 and Reynolds number for the tests, based on the mean aerodynamic chord of the vertical tail, varied with Mach number from 1.9×10^6 to 2.4×10^6 (fig. 4). The tail models were tested at angles of attack of 0° and 4° through an angle-of-sideslip range of about -2° to 23° .

Blockage corrections to Mach number were computed by the method of reference 5. Longitudinal-force data are presented as absolute values with no base-pressure adjustments applied to account for the difference in pressure at the base of the models and that of static free stream. Jet-boundary corrections, because of the low ratio of the spans of vertical and horizontal tails to the dimensions of the wind tunnel-test section, were negligible and therefore were not applied.

For the force tests the angles of attack and sideslip were corrected for deflection of the balance system under load. For data obtained from

the pressure-survey tests of references 1 and 2, deflection of the support system was small and no corrections were applied (refs. 1 and 2).

No corrections were applied to the data of this paper to account for the distortion of the vertical and horizontal surfaces while under aerodynamic load. The distortion of the vertical surface under load, however, was determined by static tests and by the theoretical methods of reference 6 for the pressure-survey tests reported in references 1 and 2. Applied static loads representative of aerodynamic loads obtained in the wind-tunnel tests at high angles of sideslip resulted in a maximum change in local angle of sideslip of the vertical tail of about 0.9° (refs. 1 and 2). Distortions calculated by the method of reference 6 for the same loading conditions agreed reasonably with the results of the static tests (refs. 1 and 2).

REDUCTION OF PRESSURE DATA

Integrated values of lateral-force coefficient C_Y and rolling-moment coefficient C_l were determined by a numerical summation of section normal-force coefficient c_n over the exposed vertical tail (refs. 1 and 2) and are based on vertical-tail area and span extending to the fuselage center line. (The coefficients C_Y and C_l are counterparts of vertical-tail normal-force coefficient and root-bending-moment coefficient which were based on exposed vertical-tail area and presented in refs. 1 and 2.) For computing C_Y and C_l , values of c_n were assumed to be effective over a span segment b' , with a moment arm l , which extended from the fuselage center line to the centroid of the span segment (fig. 5) such that

$$C_Y = \sum (c_{n1} b' l_1 c + \dots + c_{n6} b' l_6 c) \frac{l}{S}$$

and

$$C_l = \sum (c_{n1} b' l_1 l_1 c + \dots + c_{n6} b' l_6 l_6 c) \frac{1}{b_v S}$$

PRESENTATION OF RESULTS

Tabulated values of the coefficients of forces and moments, C_N , $-C_X$, C_m , C_l , C_n , and C_Y , as obtained in the present investigation, are presented in tables I to IX. For convenient reference, representative pressure distributions and span loadings obtained on the vertical tail in the investigations of references 1 and 2 are included in the present paper. The results illustrated are as follows:

Figure

Comparisons of the chordwise pressure distributions at station $0.200b_v$ of the vertical tail for fuselage—vertical-tail combination with and without the horizontal tail at $0b_v$. $\alpha = 0^\circ$; $M = 0.60$ and 0.95 .

6

Comparisons of the chordwise pressure distributions at station $0.450b_v$ of the vertical tail for fuselage—vertical-tail combination with and without the horizontal tail at $0.5b_v$. $\alpha = 0^\circ$; $M = 0.60$ and 0.95 .

7

Comparisons of the chordwise pressure distributions at station $0.931b_v$ of the vertical tail for fuselage—vertical-tail combination with and without the horizontal tail at $1.0b_v$. $\alpha = 0^\circ$; $M = 0.60$ and 0.95 .

8

The variation of c_n over the span of the vertical tail for fuselage—vertical-tail combination with and without the horizontal tail at $0b_v$, $0.5b_v$, and $1.0b_v$.
 $\alpha = 0^\circ$; $M = 0.60$ and 0.95 .

9

The variation of C_Y with β at various Mach numbers.
 $\alpha = 0^\circ$ and 4° .

10 and 11

The variation of $C_{Y\beta}$ with M . $\alpha = 0^\circ$.

12

The variation of ΔC_Y with horizontal-tail height at $\alpha = 0^\circ$ and $\beta = 4^\circ$ and 12° .

13

The variation of C_l with β at various Mach numbers.
 $\alpha = 0^\circ$ and 4° .

14 and 15

Figure

- The variation of ΔC_l with horizontal-tail height at $\alpha = 0^\circ$ and $\beta = 4^\circ$ and 12° . 16
- The variation of $C_{l\beta}$ with M. $\alpha = 0^\circ$. 17
- Horseshoe-vortex representation of model with fuselage plus vertical tail with horizontal tail located at $1.0b_v$. (In application of the theory, adjacent trailing vortices are considered coincident.) 18
- Typical calculated load distribution on the tail assembly with horizontal tail at Ob_v , $0.5b_v$ and $1.0b_v$. 19
- Comparisons of the variations of $C_{Y\beta}$ with Mach number as obtained by force tests, pressure tests, and theory. $\alpha = 0^\circ$. 20
- Comparisons of the variations of $C_{l\beta}$ with Mach number as obtained by force tests, pressure tests, and theory. $\alpha = 0^\circ$. 21

RESULTS AND DISCUSSION

Lateral-force coefficient.— The variation of C_Y with β at $\alpha = 0^\circ$ and 4° as obtained by force tests and integrated vertical-tail span loads indicates similar and generally linear trends at low sideslip angles for all tail configurations (figs. 10 and 11). A lower rate of increase of C_Y with β occurred for all configurations beginning at sideslip angles of about 8° to 16° and continuing to the highest angles investigated. The reduced variation of C_Y with β apparently resulted from the decreased loadings near the tip of the vertical tail. (See span loadings at $M = 0.60$ and 0.95 in fig. 9 and the chordwise pressure distributions on the vertical tail at sideslip angles above about 8° to 16° in refs. 1 and 2.)

For all tail configurations $C_{Y\beta}$ as obtained by the two experimental test methods generally increased negatively with increase in Mach number (fig. 12). For a horizontal-tail position of $1.0b_v$, values of $C_{Y\beta}$ were

somewhat greater than for the vertical tail and fuselage alone (fig. 12) because of the end-plate effect of the horizontal tail as predicted by references 2 to 4. This increased loading on the vertical tail caused by the high horizontal tail is apparent in figures 8 and 9 for the low sideslip angles at which $C_{Y\beta}$ is measured. Only slight changes of $C_{Y\beta}$

were obtained for a horizontal-tail location of $0.5b_v$ (fig. 12) as predicted by references 2 to 4. For the horizontal tail in the low position ($h/b_v = 0$), the increase in $C_{Y\beta}$ due to end-plate effect was somewhat

less than for the high horizontal tail (fig. 12) because of the predominant end-plate effect on the loadings on the vertical tail of the rather large fuselage which was always present for these tests (ref. 7) and which effectively masked any further increase in loading due to the presence of the low horizontal tail (figs. 6 and 9).

The variations of ΔC_Y with horizontal-tail height at $\alpha = 0^\circ$ and a low sideslip angle of 4° (fig. 13) are, of course, direct reflections of the variations of $C_{Y\beta}$ for the various tail assemblies (fig. 12) and

therefore show the end-plate effects of the horizontal tail at low angles of sideslip. At a sideslip angle of 12° , however, for the high horizontal-tail position, the end-plate effects of the horizontal tail are not apparent (fig. 13) because of flow separation near the tip of the vertical tail (fig. 9).

Rolling-moment coefficient.- For all tail configurations the variation of C_l with β as obtained by the two test methods was linear up to sideslip angles of 8° to 12° for angles of attack of 0° and 4° (figs. 14 and 15). Above $\beta = 8^\circ$ to 12° , the variation of C_l with β generally decreased for all tail configurations, the decrease reflecting the combined effects on the vertical and horizontal tails of the reduction in variation of lateral-force coefficient at these sideslip angles (figs. 10 and 11) and the inboard shift of the center of load on the vertical tail due to tip separation on the vertical tail (fig. 9 and refs. 1 and 2). The total rolling moments in sideslip acting upon the complete model configurations of the present investigation result from the lateral force on the vertical tail and from the loads induced on the horizontal tail by the loads carried by the vertical tail and fuselage. Since values of rolling-moment coefficient C_l obtained from the integrated vertical-tail span loadings account only for the lateral loads on the vertical tail and since values of C_l obtained from force tests include all rolling moments acting on the tail assembly, the differences in value of C_l at constant values of β as obtained by the two test methods are an indication of the moments due to the loading on the horizontal tail. As shown in figures 14(a) and 16, therefore, for a horizontal-tail location of $0b_v$,

the induced loading on the horizontal tail contributed a rolling moment opposite in sign to that of the vertical tail, resulting in a total rolling moment for the tail assembly as much as 30 percent less than that contributed by the vertical tail, a condition also shown in references 3 and 4. For horizontal-tail locations of $0.5b_v$ and $1.0b_v$, the loading on the horizontal tail was such as to impart a rolling moment of the same sign as that of the vertical tail (refs. 3 and 4), resulting in a value of ΔC_l for the high-tail configuration that was about 20 percent more than that contributed by the vertical tail (fig. 16). It is apparent therefore that the rolling moment contributed by the induced loading on the horizontal tail can be of particular importance when considering bending moment at the root of the vertical tail.

The variations of $C_{l\beta}$ with Mach number at $\alpha = 0^\circ$ as obtained from integrated vertical-tail span loads (fig. 17) show a general negative increase of $C_{l\beta}$ with Mach number for all tail configurations. End-plate effects of the horizontal tail at $0b_v$ and $1.0b_v$ increased the values of $C_{l\beta}$ obtained over those obtained for the vertical-tail-fuselage-alone configuration and the presence of the horizontal tail at $0.5b_v$ decreased the value of $C_{l\beta}$ obtained (fig. 17). For values of $C_{l\beta}$ obtained from the force tests of the present investigation, the effects of the induced loadings on the horizontal tail (refs. 3 and 4) are again apparent in the lower negative values of $C_{l\beta}$ obtained for the model with horizontal tail at $0b_v$ and the higher value exhibited for the model with horizontal tail at $1.0b_v$.

It is pertinent to point out the changes in the contributions to the total rolling moment of the various components of the tail assemblies as the sideslip angle was increased. The increased loading on the vertical tail due to influence of the horizontal tail (figs. 12 and 13 and refs. 3 and 4) is substantiated by the values of $C_{l\beta}$ obtained from the vertical-tail span loadings of references 1 and 2 (fig. 17) and by values of ΔC_l contributed by the vertical tail at the low sideslip angle of 4° (fig. 16). At an angle of sideslip of 12° , however, the presence of the horizontal tail at the tip of the vertical tail did not increase the loading on the vertical tail because of flow separation at the tip (figs. 9 and 13) and resulted, therefore, in no increase in the value of ΔC_l (fig. 16). Similarly, the relative contribution to ΔC_l of the complete tail assembly which was due to the load induced on the horizontal tail by the load on the vertical tail was somewhat less at a sideslip angle of 12° than was apparent at the low sideslip angle of 4° .

Care should be exercised therefore to consider that the parameter $C_{l\beta}$ is an expression of the rolling moments obtained near $\beta = 0^\circ$ and is not necessarily indicative of the moments contributed by the tail assembly at the higher sideslip angles.

Comparison of experimental and theoretical results. - Calculations to determine the theoretical loadings on the four tail configurations investigated experimentally in this paper and in references 1 and 2 were performed by using a finite-step method of replacing the tail assembly by a finite number of horseshoe vortices (refs. 3 and 4 and fig. 18). In the present investigation equal-span vortices were used to represent all surfaces, six for the vertical tail extending from the fuselage center line to the vertical-tail tip and five for each panel of the horizontal tail (fig. 18). In addition, one vortex was applied to account for fuselage depth and two to represent fuselage width as an effective end plate (ref. 4 and fig. 18). Loadings were computed for configurations with the fuselage and vertical tail alone and with the horizontal tail located at 0, 50, and 100 percent vertical-tail span and Mach number effects were approximated by the Prandtl-Glauert transformation (ref. 8). All loadings were computed in sideslip with $\alpha = 0^\circ$ to correspond to experimental test conditions, and typical loadings computed are illustrated in figure 19. Integrated results of the span loadings, expressed as $C_{Y\beta}$ and $C_{l\beta}$, were determined for the exposed area of the vertical surface alone and for the complete tail assembly in order to parallel the experimental results obtained from integrated vertical-tail span loads and from force tests, respectively. Presented in figure 20 are the variations of $C_{Y\beta}$ with Mach number as obtained from the force tests of the present investigation, from the vertical-tail span loads of references 1 and 2, and from calculated loadings. For values of $C_{Y\beta}$ based on the loads on the exposed area of the vertical tail, the computed values of $C_{Y\beta}$ were in reasonably good agreement at all Mach numbers with those obtained from the pressure tests of references 1 and 2 (fig. 20) and generally overestimated the experimental results. For values of $C_{Y\beta}$ for the complete tail assemblies (fig. 20), the computed values underestimated the experimental values probably because of the simplified representation of the fuselage (ref. 4).

The variation of $C_{l\beta}$ with Mach number as obtained from experimental force and pressure tests and from theoretical calculated loadings are presented in figure 21. For values of $C_{l\beta}$ contributed by loads on the vertical tail, the calculated values slightly overestimated the experimental values. The computed values of $C_{l\beta}$ which include the aerodynamic contributions of the complete tail assembly were in fair

agreement for the low and intermediate horizontal-tail heights but considerably overestimated the experimental values for the high horizontal-tail position (fig. 21).

CONCLUSIONS

From an investigation at high subsonic speeds of the effects of horizontal-tail height on the aerodynamic and loading characteristics in sideslip of a 45° sweptback, untapered tail assembly as obtained from force tests and from integrated experimental span loadings on the vertical tail, the following conclusions can be made:

1. The variation of lateral-force coefficient C_Y and rolling-moment coefficient C_l with sideslip angle β was generally linear at sideslip angles less than about 8° for all tail configurations at all Mach numbers investigated, with a pronounced decrease in the variation of C_Y and C_l with β at the higher sideslip angles.
2. Lateral-force coefficient obtained at sideslip angles of 4° was increased by the end-plate effect of the horizontal tail when mounted at the extreme ends of the vertical tail.
3. At constant sideslip angles, rolling-moment coefficient for the complete tail assemblies increased with increase in horizontal-tail height at an angle of attack of 0° .
4. Lateral-force-coefficient and rolling-moment-coefficient variation with sideslip $C_{Y\beta}$ and $C_{l\beta}$, respectively, generally increased with Mach number for all tail configurations investigated.
5. Values of $C_{Y\beta}$ computed for the various tail assemblies were in fair agreement with experimental results except for underestimation of the magnitude of fuselage effects. Computed values of $C_{l\beta}$ generally overestimated the experimental results.

Langley Aeronautical Laboratory,
National Advisory Committee for Aeronautics,
Langley Field, Va., April 21, 1955.

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TABLE I.- AERODYNAMIC CHARACTERISTICS OF THE TAIL ASSEMBLY;

FUSELAGE ALONE; $\alpha = 0^\circ$

M	q , lb/sq ft	β , deg	α , deg	C_N	$-C_X$	C_m	C_l	C_n	C_Y
.600	415.30	2.02-	.00	.0035-	.0297	.0029	.0008	.0117	.0267-
.600	415.30	.01-	.00	.0092-	.0305	.0037	.0002	.0087-	.0278
.600	415.30	2.02	.00	.0091-	.0317	.0036	.0007	.0332-	.0103
.600	415.30	4.03	.00	.0090-	.0324	.0042	.0008	.0549-	.0034-
.600	415.30	6.04	.00	.0090-	.0362	.0049	.0009	.0766-	.0245-
.600	415.30	8.06	.00	.0088-	.0380	.0056	.0014	.0975-	.0453-
.600	415.30	12.09	.00	.0090-	.0416	.0048	.0015	.1450-	.1077-
.600	415.30	15.13	.00	.0073-	.0442	.0032	.0017	.1857-	.1654-
.600	415.30	20.19	.02	.0719-	.0435	.0580	.0018	.2573-	.3044-
.600	415.30	23.24	.02	.1892-	.0442	.1123	.0016	.2929-	.4370-
.800	616.76	2.02-	.00	.0051-	.0289	.0001-	.0005	.0106	.0261
.800	616.76	.00	.00	.0064-	.0294	.0000	.0002	.0102-	.0261
.800	616.76	2.02	.00	.0063-	.0311	.0009	.0003	.0332-	.0084
.800	616.76	4.04	.00	.0062-	.0323	.0008	.0007	.0551-	.0078-
.800	616.76	6.06	.00	.0061-	.0344	.0017	.0008	.0757-	.0264-
.800	616.76	8.09	.00	.0061-	.0364	.0023	.0009	.0976-	.0513-
.800	616.76	12.15	.00	.0062-	.0392	.0020	.0013	.1486-	.1166-
.800	616.76	15.20	.00	.0026-	.0404	.0007-	.0016	.1914-	.1792-
.800	616.76	20.31	.02	.0496-	.0390	.0413	.0018	.2723-	.3332-
.800	616.76	23.39	.02	.1617-	.0372	.0873	.0021	.3223-	.4578-
.850	661.91	2.02-	.00	.0060-	.0300	.0001-	.0010	.0112	.0257
.850	661.91	.00	.00	.0059-	.0296	.0000	.0000-	.0091-	.0243
.850	661.91	2.02	.00	.0059-	.0300	.0003	.0006	.0335-	.0087
.850	661.91	4.04	.00	.0058-	.0324	.0008	.0007	.0564-	.0101-
.850	661.91	6.07	.00	.0069-	.0351	.0012	.0008	.0783-	.0312-
.850	661.91	8.10	.00	.0058-	.0362	.0011	.0009	.0997-	.0556-
.850	661.91	12.15	.00	.0058-	.0395	.0009	.0012	.1492-	.1201-
.850	661.91	15.22	.00	.0027-	.0397	.0030-	.0016	.1916-	.1831-
.850	661.91	20.35	.02	.0465-	.0384	.0360	.0018	.2788-	.3417-
.850	661.91	23.43	.02	.1473-	.0362	.0788	.0021	.3359-	.4661-

TABLE I.- AERODYNAMIC CHARACTERISTICS OF THE TAIL ASSEMBLY;

FUSELAGE ALONE; $\alpha = 0^\circ$ - Concluded

M	q , lb/sq ft	β , deg	α , deg	C_N	$-C_X$	C_m	C_l	C_n	C_Y
.900	703.67	2.02-	.00	.0034-	.0303	.0001-	.0007	.0106	.0219
.900	703.67	.00	.00	.0056-	.0296	.0001-	.0004	.0100-	.0217
.900	703.67	2.03	.00	.0055-	.0308	.0003	.0005	.0325-	.0060
.900	703.67	4.05	.00	.0054-	.0322	.0007	.0008	.0555-	.0109-
.900	703.67	6.07	.00	.0053-	.0351	.0015	.0009	.0775-	.0331-
.900	703.67	8.10	.00	.0053-	.0362	.0019	.0013	.0996-	.0574-
.900	703.67	12.17	.00	.0054-	.0389	.0016	.0016	.1495-	.1228-
.900	703.67	15.23	.00	.0002-	.0398	.0029-	.0018	.1946-	.1880-
.900	703.67	20.37	.01	.0434-	.0378	.0270	.0022	.2834-	.3498-
.900	703.67	23.48	.01	.1347-	.0356	.0674	.0027	.3486-	.4833-
.950	741.42	2.02-	.00	.0054-	.0308	.0001-	.0004	.0105	.0199
.950	741.42	.00	.00	.0053-	.0305	.0001-	.0004	.0099-	.0205
.950	741.42	2.03	.00	.0052-	.0319	.0007	.0007	.0327-	.0033
.950	741.42	4.05	.00	.0062-	.0333	.0007	.0010	.0554-	.0106-
.950	741.42	6.08	.00	.0051-	.0357	.0011	.0009	.0777-	.0339-
.950	741.42	8.12	.00	.0051-	.0373	.0017	.0014	.0995-	.0725-
.950	741.42	12.18	.00	.0053-	.0399	.0005-	.0016	.1491-	.1242-
.950	741.42	15.25	.00	.0002-	.0408	.0028-	.0017	.1952-	.1910-
.950	741.42	20.40	.01	.0412-	.0382	.0257	.0021	.2862-	.3546-
.950	741.42	23.52	.00	.0973-	.0365	.0328	.0027	.3704-	.4837-

TABLE II.- AERODYNAMIC CHARACTERISTICS OF THE TAIL ASSEMBLY;

FUSELAGE PLUS VERTICAL TAIL; $\alpha = 0^\circ$

M	q , lb/sq ft	β , deg	α , deg	C_N	$-C_X$	C_m	C_l	C_n	C_Y
.600	420.48	2.04-	.00	.0065-	.0415	.0018	.0537	.0147	.1302-
.600	420.48	.00	.00	.0072-	.0426	.0034	.0023	.0055-	.0026
.600	420.48	2.04	.00	.0080-	.0418	.0043	.0435-	.0251-	.1241-
.600	420.48	4.08	.00	.0146-	.0370	.0091	.0928-	.0461-	.2556-
.600	420.48	6.14	.00	.0362-	.0333	.0252	.1477-	.0709-	.4191-
.600	420.48	8.18	.01	.0665-	.0325	.0522	.2027-	.0883-	.5837-
.600	420.48	12.29	.03	.1532-	.0380	.1382	.2996-	.1168-	.9413-
.600	420.48	15.36	.05	.2132-	.0385	.1842	.3437-	.1615-	1.1653-
.600	420.48	20.46	.03	.2551-	.0431	.1769	.3651-	.2408-	1.4102-
.600	420.48	23.50	.00	.1408-	.0481	.0814	.3613-	.2808-	1.4524-
.800	624.66	2.06-	.01	.0034-	.0383	.0019	.0530	.0140	.1288
.800	624.66	.00	.00	.0063-	.0382	.0001	.0025	.0038-	.0047
.800	624.66	2.07	.00	.0053-	.0374	.0028	.0480-	.0237-	.1302-
.800	624.66	4.14	.00	.0173-	.0324	.0091	.0999-	.0473-	.2759-
.800	624.66	6.21	.00	.0407-	.0291	.0273	.1576-	.0674-	.4338-
.800	624.66	8.28	.01	.0748-	.0286	.0565	.2104-	.0859-	.6000-
.800	624.66	12.42	.05	.1721-	.0376	.1415	.2908-	.1197-	.9267-
.800	624.66	15.54	.07	.2368-	.0426	.1865	.3155-	.1682-	1.1276-
.800	624.66	20.65	.03	.2639-	.0478	.1546	.3316-	.2321-	1.3149-
.800	624.66	23.73	.02-	.1672-	.0427	.0636	.3521-	.2871-	1.4051-
.850	670.38	2.06-	.01	.0030-	.0377	.0013	.0544	.0145	.1366
.850	670.38	.00	.00	.0059-	.0378	.0003-	.0019	.0030-	.0045
.850	670.38	2.07	.00	.0064-	.0370	.0025	.0488-	.0235-	.1332-
.850	670.38	4.15	.00	.0181-	.0322	.0082	.1034-	.0459-	.2766-
.850	670.38	6.22	.01	.0420-	.0291	.0311	.1589-	.0671-	.4410-
.850	670.38	8.31	.01	.0795-	.0289	.0591	.2176-	.0822-	.6195-
.850	670.38	12.47	.05	.1819-	.0399	.1487	.2951-	.1187-	.9470-
.850	670.38	15.56	.07	.2412-	.0439	.1857	.3144-	.1664-	1.1174-
.850	670.38	20.70	.03	.2713-	.0488	.1514	.3321-	.2320-	1.3076-
.850	670.38	23.80	.03-	.1990-	.0432	.0653	.3609-	.2911-	1.4474-

TABLE II.- AERODYNAMIC CHARACTERISTICS OF THE TAIL ASSEMBLY;

FUSELAGE PLUS VERTICAL TAIL; $\alpha = 0^\circ$ - Concluded

M	q , lb/sq ft	β , deg	α , deg	C_N	$-C_X$	C_m	C_l	C_n	C_Y
.900	712.69	2.07-	.01	.0026-	.0372	.0006	.0558	.0145	.1356
.900	712.69	.01-	.00	.0055-	.0370	.0005-	.0039	.0024-	.0130
.900	712.69	2.08	.00	.0065-	.0368	.0016	.0518-	.0225-	.1344-
.900	712.69	4.16	.00	.0178-	.0316	.0082	.1074-	.0459-	.2851-
.900	712.69	6.25	.00	.0436-	.0262	.0264	.1668-	.0682-	.4616-
.900	712.69	8.34	.01	.0887-	.0265	.0557	.2316-	.0812-	.6480-
.900	712.69	12.50	.06	.1923-	.0420	.1527	.2934-	.1222-	.9514-
.900	712.69	15.60	.07	.2523-	.0455	.1878	.3184-	.1666-	1.1294-
.950	751.17	2.07-	.01	.0022-	.0371	.0009	.0585	.0151	.1456
.950	751.17	.00	.00	.0053-	.0381	.0002-	.0013	.0027-	.0059
.950	751.17	2.09	.00	.0068-	.0371	.0017	.0591-	.0240-	.1512-
.950	751.17	4.17	.00	.0178-	.0314	.0082	.1147-	.0457-	.3046-
.950	751.17	6.27	.00	.0434-	.0268	.0229	.1791-	.0649-	.4824-
.950	751.17	8.37	.01	.0919-	.0266	.0562	.2477-	.0736-	.6828-
.950	751.17	12.53	.07	.2002-	.0448	.1579	.3039-	.1147-	.9804-

TABLE III.- AERODYNAMIC CHARACTERISTICS OF THE TAIL ASSEMBLY;
FUSELAGE PLUS VERTICAL TAIL; $\alpha = 4^\circ$

M	q , lb/sq ft	β , deg	α , deg	C _N	-C _X	C _m	C _L	C _n	C _y
.600	421.18	2.02-	4.06	.0217	.0405	.0918	.0436	.0054	.0755
.600	421.18	.00	4.06	.0232	.0406	.0925	.0014	.0069-	.0280-
.600	421.18	2.05	4.06	.0245	.0400	.0949	.0429-	.0169-	.1644-
.600	421.18	4.09	4.06	.0204	.0361	.1011	.0850-	.0316-	.2908-
.600	421.18	6.14	4.06	.0017	.0327	.1067	.1379-	.0518-	.4550-
.600	421.18	8.18	4.05	.0233-	.0286	.1074	.1871-	.0624-	.6024-
.600	421.18	12.29	4.09	.1051-	.0323	.2281	.3206-	.0717-	1.0396-
.600	421.18	15.37	4.11	.1531-	.0336	.2749	.3569-	.1190-	1.2664-
.600	421.18	20.48	4.11	.1869-	.0341	.2790	.3838-	.2101-	1.5296-
.600	421.18	23.56	4.09	.1688-	.0359	.2358	.4078-	.2977-	1.6866-
.800	625.70	2.05-	4.10	.0261	.0378	.0879	.0471	.0124	.0977
.800	625.70	.00	4.09	.0250	.0376	.0885	.0028	.0006-	.0205-
.800	625.70	2.07	4.09	.0248	.0370	.0919	.0448-	.0174-	.1642-
.800	625.70	4.14	4.08	.0170	.0327	.0981	.0900-	.0362-	.3133-
.800	625.70	6.21	4.10	.0007-	.0295	.1167	.1419-	.0495-	.4647-
.800	625.70	8.28	4.11	.0325-	.0273	.1454	.1981-	.0594-	.6445-
.800	625.70	12.43	4.15	.1227-	.0336	.2328	.3044-	.0796-	1.0331-
.800	625.70	15.54	4.17	.1769-	.0367	.2766	.3407-	.1215-	1.2486-
.800	625.70	20.70	4.16	.2107-	.0394	.2748	.3664-	.2066-	1.4996-
.800	625.70	23.78	4.13	.1796-	.0400	.2349	.3800-	.2576-	1.6163-
.850	671.50	2.06-	4.10	.0287	.0381	.0881	.0475	.0121	.0994
.850	671.50	.00	4.10	.0262	.0382	.0882	.0018	.0010-	.0225-
.850	671.50	2.07	4.10	.0248	.0373	.0919	.0453-	.0176-	.1661-
.850	671.50	4.15	4.09	.0158	.0340	.0973	.0924-	.0341-	.3076-
.850	671.50	6.23	4.11	.0047-	.0300	.1207	.1510-	.0499-	.4919-
.850	671.50	8.30	4.11	.0391-	.0285	.1480	.2020-	.0596-	.6617-
.850	671.50	12.47	4.16	.1263-	.0354	.2372	.3006-	.0794-	1.0275-
.850	671.50	15.58	4.19	.1795-	.0389	.2862	.3425-	.1199-	1.2547-

TABLE III.- AERODYNAMIC CHARACTERISTICS OF THE TAIL ASSEMBLY;
FUSELAGE PLUS VERTICAL TAIL; $\alpha = 4^\circ$ - Concluded

M	q , lb/sq ft	β , deg	α , deg	C_N	$-C_X$	C_m	C_l	C_n	C_Y
.900	714.11	2.06-	4.11	.0268	.0371	.0890	.0487	.0110	.1092
.900	714.11	.00	4.10	.0253	.0387	.0897	.0000	.0027-	.0249-
.900	714.11	2.08	4.10	.0259	.0378	.0920	.0454-	.0193-	.1635-
.900	714.11	4.15	4.10	.0162	.0340	.0989	.0949-	.0357-	.3076-
.900	714.11	6.24	4.11	.0070-	.0306	.1199	.1553-	.0490-	.4930-
.900	714.11	8.35	4.12	.0466-	.0298	.1536	.2139-	.0806-	.6827-
.900	714.11	12.49	4.18	.1319-	.0386	.2461	.2970-	.0819-	1.0340-
.950	752.42	2.06-	4.11	.0281	.0378	.0883	.0496	.0109	.1039
.950	752.42	.00	4.11	.0266	.0385	.0882	.0024	.0017-	.0218-
.950	752.42	2.09	4.11	.0270	.0383	.0927	.0473-	.0164-	.1711-
.950	752.42	4.17	4.11	.0151	.0347	.0989	.1000-	.0342-	.3315-
.950	752.42	6.26	4.11	.0051-	.0293	.1161	.1544-	.0487-	.4997-
.950	752.42	8.36	4.13	.0591-	.0347	.1662	.2342-	.0398-	.7422-
.950	752.42	12.52	4.19	.1356-	.0407	.2467	.2994-	.0762-	1.0403-

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TABLE IV.- AERODYNAMIC CHARACTERISTICS OF THE TAIL ASSEMBLY;

FUSELAGE PLUS VERTICAL TAIL PLUS HORIZONTAL TAIL

AT $0.0b_V$; $\alpha = 0^\circ$

M	a , lb/sq ft	β , deg	α , deg	C_N	$-C_X$	C_m	C_l	C_n	C_Y
.600	420.34	2.04-	.00	.0072-	.0379	.0011-	.0457	.0146	.1250
.600	420.34	.00	.00	.0077-	.0386	.0002-	.0008	.0024-	.0110-
.600	420.34	2.05	.00	.0102-	.0367	.0010	.0398-	.0230-	.1452-
.600	420.34	4.09	.00	.0131-	.0311	.0013	.0823-	.0456-	.2834-
.600	420.34	6.14	.00	.0233-	.0262	.0081	.1240-	.0669-	.4297-
.600	420.34	8.19	.01-	.0430-	.0223	.0218	.1702-	.0853-	.5955-
.600	420.34	12.29	.01	.0921-	.0265	.0747	.2353-	.1266-	.9173-
.600	420.34	15.37	.01	.1188-	.0261	.0922	.2595-	.1719-	1.1125-
.600	420.34	20.44	.02-	.1120-	.0391	.0183	.2473-	.2471-	1.2694-
.600	420.34	23.48	.05-	.1089-	.0354	.0321-	.2515-	.2885-	1.3525-
.800	624.24	2.06-	.00	.0108-	.0379	.0045-	.0465	.0102	.1282
.800	624.24	.02	.00	.0095-	.0388	.0038-	.0016	.0070-	.0158-
.800	624.24	2.08	.01-	.0122-	.0370	.0036-	.0407-	.0277-	.1538-
.800	624.24	4.15	.01-	.0128-	.0309	.0030-	.0837-	.0487-	.2969-
.800	624.24	6.22	.02-	.0275-	.0256	.0046	.1305-	.0692-	.4598-
.800	624.24	8.29	.01-	.0482-	.0236	.0208	.1748-	.0869-	.6267-
.800	624.24	12.44	.01	.1118-	.0252	.0684	.2243-	.1280-	.9225-
.800	624.24	15.52	.00	.1382-	.0358	.0712	.2154-	.1818-	1.0498-
.800	624.24	20.62	.09-	.1606-	.0438	.0289-	.2252-	.2476-	1.1844-
.800	624.24	23.71	.13-	.1881-	.0358	.0582-	.2457-	.2932-	1.3386-
.850	671.05	2.06-	.00	.0098-	.0380	.0042-	.0484	.0109	.1269
.850	671.05	.02	.00	.0074-	.0388	.0029-	.0043	.0068-	.0157-
.850	671.05	2.09	.01-	.0144-	.0375	.0053-	.0432-	.0272-	.1696-
.850	671.05	4.17	.01-	.0094-	.0311	.0056-	.0873-	.0485-	.3169-
.850	671.05	6.25	.02-	.0258-	.0254	.0032	.1349-	.0695-	.4786-
.850	671.05	8.32	.01-	.0536-	.0258	.0248	.1837-	.0799-	.6586-
.850	671.05	12.47	.01	.1148-	.0335	.0664	.2185-	.1307-	.9290-
.850	671.05	15.56	.00	.1469-	.0393	.0615	.2040-	.1832-	1.0275-
.850	671.05	20.67	.11-	.1906-	.0089-	.0312-	.2242-	.2467-	1.1871-
.850	671.05	23.77	.14-	.2098-	.0182-	.0582-	.2472-	.2945-	1.3481-

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TABLE IV.- AERODYNAMIC CHARACTERISTICS OF THE TAIL ASSEMBLY;

FUSELAGE PLUS VERTICAL TAIL PLUS HORIZONTAL TAIL

AT 0.0b_V; $\alpha = 0^\circ$ - Concluded

M	q , lb/sq ft	β , deg	α , deg	C_N	$-C_X$	C_m	C_l	C_n	C_Y
.900	713.63	2.06-	.00	.0092-	.0384	.0053-	.0499	.0116	.1277
.900	713.63	.01	.00	.0119-	.0396	.0048-	.0022	.0053-	.0272-
.900	713.63	2.10	.01-	.0139-	.0380	.0060-	.0441-	.0268-	.1812-
.900	713.63	4.18	.02-	.0179-	.0314	.0089-	.0909-	.0474-	.3370-
.900	713.63	6.27	.03-	.0262-	.0251	.0032-	.1403-	.0674-	.5020-
.900	713.63	8.36	.02-	.0539-	.0245	.0217	.1943-	.0768-	.6897-
.900	713.63	12.51	.04	.1188-	.0403	.1020	.2131-	.1305-	.9461-
.900	713.63	15.59	.02-	.1653-	.0435	.0539	.2043-	.1826-	1.0361-
.900	713.63	20.73	.13-	.2183-	.0473	.0323-	.2265-	.2475-	1.2038-
.900	713.63	23.85	.18-	.2527-	.0419	.0716-	.2555-	.2965-	1.3880-
.950	752.17	2.07-	.01-	.0117-	.0397	.0055-	.0512	.0110	.1366
.950	752.17	.01	.02-	.0138-	.0413	.0087-	.0017	.0046-	.0188-
.950	752.17	2.10	.03-	.0203-	.0223	.0104-	.0446-	.0211-	.1662-
.950	752.17	4.19	.03-	.0293-	.0351	.0103-	.0907-	.0420-	.3225-
.950	752.17	6.27	.03-	.0386-	.0278	.0044-	.1418-	.0593-	.4919-
.950	752.17	8.37	.02-	.0711-	.0266	.0177	.1999-	.0691-	.6842-
.950	752.17	12.52	.01	.1368-	.0426	.0699	.2076-	.1267-	.9258-
.950	752.17	15.62	.03-	.1816-	.0477	.0490	.1993-	.1797-	1.0236-
.950	752.17	20.81	.15-	.2479-	.0571	.0296-	.2506-	.2451-	1.3082-

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TABLE V.- AERODYNAMIC CHARACTERISTICS OF THE TAIL ASSEMBLY;

FUSELAGE PLUS VERTICAL TAIL PLUS HORIZONTAL TAIL

AT 0.0b_V; $\alpha = 4^\circ$

M	q , lb/sq ft	β , deg	α , deg	C _N	-C _X	C _m	C _L	C _n	C _Y
.600	421.46	2.03-	4.17	.3490	.0357	.1403	.0454	.0177	.0703
.600	421.46	.01	4.17	.3487	.0361	.1428	.0004	.0006	.0489-
.600	421.46	2.05	4.17	.3482	.0348	.1457	.0417-	.0182-	.1788-
.600	421.46	4.09	4.16	.3434	.0286	.1461	.0853-	.0394-	.3122-
.600	421.46	6.14	4.17	.3429	.0253	.1583	.1346-	.0588-	.4735-
.600	421.46	8.19	4.17	.3215	.0202	.1692	.1760-	.0718-	.6148-
.600	421.46	12.30	4.20	.2653	.0234	.2406	.2797-	.0918-	1.0337-
.600	421.46	15.36	4.21	.2254	.0234	.2703	.2953-	.1330-	1.2040-
.600	421.46	20.46	4.20	.1819	.0246	.2685	.2987-	.2268-	1.4525-
.600	421.46	23.53	4.17	.2032	.0302	.2227	.3124-	.2745-	1.5886-
.800	626.11	2.05-	4.26	.3789	.0309	.1410	.0473	.0114	.0933
.800	626.11	.01	4.26	.3803	.0311	.1430	.0014-	.0038-	.0476-
.800	626.11	2.08	4.27	.3805	.0295	.1462	.0433-	.0217-	.1810-
.800	626.11	4.14	4.26	.3773	.0241	.1482	.0890-	.0407-	.3221-
.800	626.11	6.21	4.26	.3575	.0200	.1570	.1380-	.0579-	.4789-
.800	626.11	8.28	4.27	.3466	.0174	.1718	.1881-	.0708-	.6560-
.800	626.11	12.44	4.30	.2970	.0243	.2337	.2561-	.1004-	1.0052-
.800	626.11	15.53	4.31	.2455	.0307	.2599	.2636-	.1465-	1.1711-
.800	626.11	20.66	4.26	.1922	.0318	.2288	.2728-	.2280-	1.3542-
.800	626.11	23.75	4.23	.1438	.0301	.2142	.2956-	.2669-	1.5178-
.850	671.72	2.06-	4.29	.3917	.0303	.1402	.0488	.0120	.0927
.850	671.72	.01	4.29	.3978	.0309	.1434	.0016	.0036-	.0461-
.850	671.72	2.08	4.28	.3924	.0285	.1422	.0428-	.0198-	.1837-
.850	671.72	4.15	4.28	.3882	.0237	.1460	.0877-	.0384-	.3250-
.850	671.72	6.24	4.29	.3788	.0199	.1569	.1419-	.0564-	.5001-
.850	671.72	8.32	4.27	.3561	.0183	.1563	.2034-	.0609-	.6994-
.850	671.72	12.47	4.33	.2969	.0272	.2359	.2577-	.0944-	1.0171-
.850	671.72	15.57	4.32	.2518	.0337	.2507	.2602-	.1445-	1.1613-
.850	671.72	20.71	4.28	.1748	.0341	.2363	.2750-	.2253-	1.3736-
.850	671.72	23.81	4.22	.1119	.0310	.2011	.3023-	.2656-	1.5415-

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TABLE V.- AERODYNAMIC CHARACTERISTICS OF THE TAIL ASSEMBLY;

FUSELAGE PLUS VERTICAL TAIL PLUS HORIZONTAL TAIL

AT $0.0b_V$; $\alpha = 4^\circ$ - Concluded

M	a , lb/sq ft	β , deg	α , deg	C_N	$-C_X$	C_m	C_l	C_n	C_Y
.900	714.34	2.06-	4.32	.4135	.0298	.1400	.0494	.0117	.0923
.900	714.34	.01	4.31	.4222	.0308	.1418	.0004-	.0035-	.0536-
.900	714.34	2.09	4.31	.4182	.0300	.1431	.0448-	.0192-	.2008-
.900	714.34	4.16	4.31	.4105	.0247	.1452	.0903-	.0362-	.3421-
.900	714.34	6.26	4.30	.3884	.0198	.1531	.1460-	.0525-	.5195-
.900	714.34	8.33	4.32	.3581	.0223	.1818	.2114-	.0502-	.7228-
.900	714.34	12.49	4.35	.2792	.0323	.2431	.2617-	.0847-	1.0257-
.900	714.34	15.59	4.35	.2353	.0390	.2605	.2590-	.1365-	1.1504-
.900	714.34	20.76	4.31	.1478	.0390	.2566	.2788-	.2157-	1.4062-
.900	714.34	23.88	4.26	.0891	.0381	.2366	.3071-	.2643-	1.5891-
.950	752.67	2.06-	4.33	.4214	.0337	.1309	.0500	.0127	.0964
.950	752.67	.01	4.32	.4238	.0354	.1299	.0001-	.0008-	.0518-
.950	752.67	2.10	4.32	.4209	.0334	.1325	.0478-	.0169-	.2007-
.950	752.67	4.17	4.31	.4208	.0307	.1340	.0939-	.0344-	.3453-
.950	752.67	6.27	4.31	.3889	.0253	.1452	.1515-	.0458-	.5304-
.950	752.67	8.35	4.31	.3438	.0260	.1693	.2103-	.0477-	.7168-
.950	752.67	12.52	4.36	.2673	.0413	.2415	.2660-	.0757-	1.0313-
.950	752.67	15.62	4.35	.2197	.0446	.2517	.2602-	.1299-	1.1504-
.950	752.67	20.81	4.31	.1392	.0473	.2394	.2998-	.2059-	1.4505-

TABLE VI.- AERODYNAMIC CHARACTERISTICS OF THE TAIL ASSEMBLY;

FUSELAGE PLUS VERTICAL TAIL PLUS HORIZONTAL TAIL

AT $0.5b_V$; $\alpha = 0^\circ$

M	a , lb/sq ft	β , deg	α , deg	C_N	$-C_X$	C_m	C_l	C_n	C_Y
.600	420.20	2.06-	.01	.0160-	.0493	.0230	.0556	.0106-	.1216
.600	420.20	.00	.00	.0184-	.0493	.0211	.0053	.0254	.0174
.600	420.20	2.07	.00	.0188-	.0488	.0301	.0481-	.0378-	.1288-
.600	420.20	4.14	.00	.0249-	.0432	.0466	.0978-	.0629-	.2675-
.600	420.20	6.20	.01	.0461-	.0374	.0865	.1517-	.0914-	.4123-
.600	420.20	8.28	.01	.0697-	.0336	.1342	.2099-	.1107-	.5839-
.600	420.20	12.44	.01	.1427-	.0322	.2329	.3114-	.1293-	.9225-
.600	420.20	15.53	.00	.2035-	.0316	.2986	.3731-	.1428-	1.1428-
.600	420.20	20.63	.07-	.3396-	.0536	.3781	.3763-	.1792-	1.3359-
.600	420.20	23.70	.14-	.4519-	.0501	.4161	.4025-	.1971-	1.4736-
.800	624.24	2.10-	.00	.0153-	.0451	.0163	.0586	.0208	.1409
.800	624.24	.00	.00	.0127-	.0463	.0120	.0055	.0100-	.0123
.800	624.24	2.11	.00	.0154-	.0453	.0201	.0505-	.0395-	.1331-
.800	624.24	4.21	.00	.0284-	.0393	.0448	.1035-	.0659-	.2763-
.800	624.24	6.33	.01	.0483-	.0345	.0844	.1632-	.0915-	.4471-
.800	624.24	8.44	.02	.0766-	.0310	.1346	.2206-	.1082-	.6220-
.800	624.24	12.64	.01	.1582-	.0348	.2410	.3140-	.1262-	.9334-
.800	624.24	15.76	.03-	.2393-	.0403	.3195	.3451-	.1374-	1.1049-
.800	624.24	20.94	.13-	.4018-	.0546	.4179	.3533-	.1791-	1.3517-
.800	624.24	24.05	.23-	.5273-	.0489	.4807	.3951-	.2195-	1.4847-
.850	669.72	2.10-	.01-	.0155-	.0458	.0131	.0607	.0173	.1442
.850	669.72	.01-	.01-	.0131-	.0469	.0097	.0082	.0126-	.0166
.850	669.72	2.12	.01-	.0163-	.0457	.0170	.0522-	.0422-	.1387-
.850	669.72	4.24	.01-	.0312-	.0412	.0431	.1054-	.0696-	.2849-
.850	669.72	6.36	.00	.0502-	.0347	.0820	.1658-	.0918-	.4589-
.850	669.72	8.50	.01	.0796-	.0320	.1375	.2298-	.1101-	.6435-
.850	669.72	12.70	.00	.1817-	.0396	.2633	.3156-	.1293-	.9481-

TABLE VI.- AERODYNAMIC CHARACTERISTICS OF THE TAIL ASSEMBLY;

FUSELAGE PLUS VERTICAL TAIL PLUS HORIZONTAL TAIL

AT $0.5b_V$; $\alpha = 0^\circ$ - Concluded

M	q , lb/sq ft	β , deg	α , deg	C_N	$-C_X$	C_m	C_l	C_n	C_Y
.900	711.97	2.11-	.01-	.0147-	.0459	.0103	.0596	.0170	.1386
.900	711.97	.01	.01-	.0138-	.0475	.0086	.0061	.0141-	.0111
.900	711.97	2.12	.02-	.0180-	.0467	.0162	.0507-	.0394-	.1369-
.900	711.97	4.26	.01-	.0336-	.0417	.0432	.1075-	.0684-	.2934-
.900	711.97	6.39	.01-	.0591-	.0362	.0875	.1718-	.0967-	.4678-
.900	711.97	8.54	.01-	.0994-	.0322	.1495	.2386-	.1106-	.6568-
.900	711.97	12.75	.02-	.2058-	.0425	.2831	.3177-	.1260-	.9593-
.950	750.42	2.12-	.02-	.0233-	.0510	.0101	.0621	.0143	.1505
.950	750.42	.00	.02-	.0225-	.0505	.0088	.0082	.0129-	.0168
.950	750.42	2.14	.02-	.0273-	.0488	.0213	.0488-	.0406-	.1337-
.950	750.42	4.27	.03-	.0447-	.0440	.0490	.1074-	.0694-	.2913-
.950	750.42	6.41	.02-	.0705-	.0376	.0929	.1724-	.0959-	.4656-
.950	750.42	8.59	.02-	.1222-	.0357	.1682	.2508-	.1082-	.6872-
.950	750.42	12.81	.03-	.2185-	.0133	.2959	.3131-	.1365-	.9628-

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TABLE VII.- AERODYNAMIC CHARACTERISTICS OF THE TAIL ASSEMBLY;

FUSELAGE PLUS VERTICAL TAIL PLUS HORIZONTAL TAIL

AT $0.5b_V$; $\alpha = 1^\circ$

M	q , lb/sq ft	β , deg	α , deg	C_N	$-C_X$	C_m	C_l	C_n	C_Y
.600	419.92	2.05-	4.17	.2979	.0379	.1435-	.0513	.0330	.0775
.600	419.92	.00	4.16	.3013	.0378	.1454-	.0015	.0062	.0447-
.600	419.92	2.08	4.17	.3031	.0365	.1402-	.0470-	.0147-	.1822-
.600	419.92	4.14	4.17	.2987	.0312	.1258-	.0990-	.0319-	.3353-
.600	419.92	6.22	4.17	.2847	.0231	.0974-	.1524-	.0520-	.4858-
.600	419.92	8.29	4.17	.2625	.0218	.0580-	.2086-	.0654-	.6477-
.600	419.92	12.45	4.16	.1748	.0153	.0474	.3353-	.0790-	1.0249-
.600	419.92	15.55	4.14	.1172	.0117	.0924	.4027-	.0996-	1.2438-
.600	419.92	20.63	4.07	.0391	.0417	.0681	.4146-	.1444-	1.4084-
.600	419.92	23.69	4.08	.1038	.0501	.0039	.4304-	.1877-	1.4802-
.800	623.82	2.16-	4.26	.3255	.0336	.1675-	.0521	.1340	.0976
.800	623.82	.01	4.26	.3329	.0339	.1743-	.0018	.0066	.0430-
.800	623.82	2.12	4.26	.3301	.0326	.1667-	.0529-	.0119-	.1994-
.800	623.82	4.22	4.26	.3195	.0275	.1482-	.1023-	.0324-	.3383-
.800	623.82	6.33	4.26	.3042	.0215	.1179-	.1623-	.0495-	.5123-
.800	623.82	8.44	4.26	.2776	.0163	.0771-	.2218-	.0593-	.6878-
.800	623.82	12.66	4.24	.1767	.0131	.0348	.3349-	.0733-	1.0317-
.800	623.82	15.78	4.18	.1013	.0213	.0848	.3737-	.0949-	1.2013-
.850	665.48	2.09-	4.29	.3423	.0290	.1827-	.0524	.0320	.0805
.850	665.48	.02	4.28	.3447	.0289	.1841-	.0008-	.0117	.0660-
.850	665.48	2.13	4.28	.3431	.0271	.1766-	.0548-	.0068-	.2253-
.850	665.48	4.25	4.28	.3289	.0216	.1543-	.1083-	.0254-	.3754-
.850	665.48	6.37	4.28	.3079	.0159	.1219-	.1658-	.0420-	.5430-
.850	665.48	8.49	4.28	.2785	.0111	.0778-	.2293-	.0552-	.7210-
.850	665.48	12.72	4.25	.1759	.0120	.0375	.3357-	.0663-	1.0697-

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TABLE VII.- AERODYNAMIC CHARACTERISTICS OF THE TAIL ASSEMBLY;

FUSELAGE PLUS VERTICAL TAIL PLUS HORIZONTAL TAIL

AT $0.5b_v$; $\alpha = 4^\circ$ - Concluded

M	a , lb/sq ft	β , deg	α , deg	C_N	$-C_X$	C_m	C_l	C_n	C_Y
.900	707.70	2.09-	4.31	.3562	.0301	.1970-	.0538	.0291	.0831
.900	707.70	.03	4.30	.3582	.0311	.1995-	.0012	.0113	.0657-
.900	707.70	2.15	4.30	.3552	.0290	.1912-	.0542-	.0090-	.2185-
.900	707.70	4.27	4.31	.3485	.0246	.1744-	.1100-	.0279-	.3811-
.900	707.70	6.40	4.30	.3223	.0184	.1364-	.1718-	.0439-	.5532-
.900	707.70	8.53	4.30	.2810	.0131	.0835-	.2369-	.0499-	.7402-
.900	707.70	12.76	4.27	.1728	.0154	.0364	.3352-	.0622-	1.0545-
.950	745.92	2.09-	4.32	.3607	.0345	.2098-	.0513	.0280	.0788
.950	745.92	.03	4.31	.3617	.0362	.2088-	.0011	.0109	.0671-
.950	745.92	2.15	4.31	.3567	.0359	.1986-	.0527-	.0082-	.2207-
.950	745.92	4.29	4.32	.3444	.0331	.1773-	.1097-	.0266-	.3838-
.950	745.92	6.42	4.32	.3214	.0263	.1426-	.1707-	.0412-	.5560-
.950	745.92	8.57	4.31	.2717	.0203	.0780-	.2408-	.0478-	.7542-
.950	745.92	10.70	4.30	.2284	.0209	.0242-	.2983-	.0501-	.9285-

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TABLE VIII.- AERODYNAMIC CHARACTERISTICS OF THE TAIL ASSEMBLY;

FUSELAGE PLUS VERTICAL TAIL PLUS HORIZONTAL TAIL

AT $1.0b_V$; $\alpha = 0^\circ$

M	q , lb/sq ft	β , deg	α , deg	C_N	$-C_X$	C_m	C_l	C_n	C_Y
.600	417.12	2.06-	.02	.0411-	.0417	.0826	.0606	.0174	.1192
.600	417.12	.01	.02	.0447-	.0403	.0866	.0140-	.0046-	.0173-
.600	417.12	2.08	.01	.0432-	.0381	.0851	.0886-	.0269-	.1727-
.600	417.12	4.15	.01	.0461-	.0299	.0873	.1596-	.0497-	.3240-
.600	417.12	6.23	.00	.0541-	.0257	.0905	.2311-	.0803-	.4906-
.600	417.12	8.31	.01-	.0572-	.0276	.0836	.2942-	.1035-	.6660-
.600	417.12	12.43	.03-	.0599-	.0277	.0524	.3499-	.1531-	.9112-
.600	417.12	15.53	.06-	.0786-	.0237	.0247	.3933-	.1857-	1.0976-
.600	417.12	20.66	.14-	.1191-	.0249	.0522-	.4470-	.2155-	1.3664-
.600	417.12	23.73	.22-	.1109-	.0222	.1920-	.4752-	.2422-	1.5006-
.800	619.67	2.09-	.03	.0494-	.0382	.0960	.0656	.0188	.1291
.800	619.67	.01	.02	.0521-	.0388	.0965	.0141-	.0035-	.0177-
.800	619.67	2.12	.01	.0535-	.0367	.0939	.0952-	.0269-	.1823-
.800	619.67	4.23	.00	.0545-	.0300	.0891	.1690-	.0510-	.3384-
.800	619.67	6.35	.02-	.0620-	.0225	.0828	.2351-	.0777-	.4924-
.800	619.67	8.47	.03-	.0752-	.0219	.0850	.2966-	.1033-	.6642-
.800	619.67	12.66	.08-	.0643-	.0306	.0161	.3502-	.1501-	.9262-
.800	619.67	15.78	.13-	.0863-	.0284	.0175-	.3796-	.1725-	1.0830-
.850	664.58	2.10-	.03	.0529-	.0385	.0978	.0684	.0207	.1332
.850	664.58	.02	.02	.0508-	.0397	.0965	.0176-	.0037-	.0297-
.850	664.58	2.14	.01	.0524-	.0366	.0929	.0932-	.0235-	.1851-
.850	664.58	4.26	.01-	.0572-	.0303	.0869	.1729-	.0514-	.3459-
.850	664.58	6.39	.03-	.0645-	.0221	.0788	.2452-	.0808-	.5123-
.850	664.58	8.51	.04-	.0766-	.0216	.0785	.3052-	.1027-	.6840-
.850	664.58	12.71	.10-	.0537-	.0320	.0177-	.3507-	.1519-	.9156-

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TABLE VIII.-- AERODYNAMIC CHARACTERISTICS OF THE TAIL ASSEMBLY;

FUSELAGE PLUS VERTICAL TAIL PLUS HORIZONTAL TAIL

AT $1.0b_V$; $\alpha = 0^\circ$ - Concluded

M	a , lb/sq ft	β , deg	α , deg	C_N	$-C_X$	C_m	C_l	C_n	C_Y
.900	706.76	2.11-	.03	.0548-	.0390	.1017	.0694	.0192	.1317
.900	706.76	.01	.03	.0530-	.0397	.0991	.0144-	.0033-	.0215-
.900	706.76	2.14	.01	.0533-	.0375	.0933	.0991-	.0243-	.1939-
.900	706.76	4.28	.01-	.0599-	.0299	.0870	.1795-	.0514-	.3610-
.900	706.76	6.43	.04-	.0670-	.0197	.0720	.2627-	.0788-	.5402-
.900	706.76	8.56	.07-	.0730-	.0146	.0510	.3250-	.1032-	.7047-
.950	744.67	2.12-	.03	.0557-	.0406	.1022	.0764	.0216	.1433
.950	744.67	.02	.03	.0522-	.0408	.0987	.0124-	.0003-	.0247-
.950	744.67	2.16	.01	.0534-	.0381	.0910	.1029-	.0241-	.2021-
.950	744.67	4.30	.01-	.0573-	.0300	.0802	.1845-	.0506-	.3694-
.950	744.67	6.46	.05-	.0654-	.0205	.0625	.2701-	.0740-	.5498-
.950	744.67	8.61	.09-	.0601-	.0149	.0190	.3429-	.0965-	.7286-

TABLE IX.- AERODYNAMIC CHARACTERISTICS OF THE TAIL ASSEMBLY;

FUSELAGE PLUS VERTICAL TAIL PLUS HORIZONTAL TAIL

AT $1.0b_V$; $\alpha = 4^\circ$

M	q , lb/sq ft	β , deg	α , deg	C_N	$-C_X$	C_m	C_l	C_n	C_Y
.600	417.40	2.06	4.01	.2703	.0285	.3779-	.0538	.0041-	.1604
.600	417.40	.01	4.00	.2710	.0289	.3759-	.0143-	.0195-	.0138
.600	417.40	2.08	4.00	.2672	.0255	.3708-	.0816-	.0338-	.1362-
.600	417.40	4.14	3.99	.2625	.0184	.3651-	.1532-	.0545-	.2988-
.600	417.40	6.22	3.99	.2553	.0143	.3589-	.2198-	.0726-	.4640-
.600	417.40	8.31	3.98	.2406	.0139	.3502-	.2915-	.0811-	.6504-
.600	417.40	12.45	3.95	.2093	.0086	.3474-	.3879-	.1197-	.9719-
.600	417.40	15.54	3.93	.1875	.0039	.3646-	.4304-	.1554-	1.1483-
.600	417.40	20.69	3.83	.1410	.0068	.4562-	.4952-	.1996-	1.4505-
.600	417.40	23.78	3.75	.0303	.0037	.4458-	.5328-	.2158-	1.6426-
.800	619.26	2.10	4.00	.2785	.0344	.3895-	.0595	.0181-	.1946
.800	619.26	.00	4.01	.2792	.0353	.3866-	.0149-	.0312-	.0331
.800	619.26	2.11	4.00	.2773	.0320	.3869-	.0854-	.0455-	.1195-
.800	619.26	4.21	3.99	.2724	.0248	.3889-	.1578-	.0620-	.2870-
.800	619.26	6.34	3.97	.2611	.0184	.3859-	.2301-	.0787-	.4697-
.800	619.26	8.45	3.95	.2520	.0164	.3955-	.2957-	.0931-	.6444-
.800	619.26	12.67	3.88	.2399	.0121	.4596-	.3906-	.1244-	.9574-
.850	664.58	2.11	4.01	.2886	.0341	.4064-	.0603	.0152-	.1917
.850	664.58	.00	4.00	.2854	.0353	.3991-	.0162-	.0300-	.0304
.850	664.58	2.12	3.99	.2864	.0315	.4045-	.0901-	.0451-	.1292-
.850	664.58	4.24	3.98	.2810	.0244	.4079-	.1643-	.0608-	.2976-
.850	664.58	6.38	3.95	.2767	.0170	.4201-	.2425-	.0770-	.4891-
.850	664.58	8.50	3.92	.2740	.0137	.4514-	.3097-	.0923-	.6594-

TABLE IX.- AERODYNAMIC CHARACTERISTICS OF THE TAIL ASSEMBLY;

FUSELAGE PLUS VERTICAL TAIL PLUS HORIZONTAL TAIL

AT $l \cdot 0 b_V$; $\alpha = 4^\circ$ - Concluded

M	q , lb/sq ft	β , deg	α , deg	C_N	$-C_X$	C_m	C_l	C_n	C_Y
.900	706.52	2.12-	4.00	.3020	.0329	.4299-	.0633	.0198-	.2080
.900	706.52	.00	3.99	.3009	.0342	.4262-	.0146-	.0311-	.0405
.900	706.52	2.13	3.99	.3065	.0313	.4404-	.0938-	.0458-	.1257-
.900	706.52	4.26	3.97	.2996	.0230	.4422-	.1691-	.0606-	.3026-
.900	706.52	6.40	3.93	.3003	.0156	.4705-	.2511-	.0791-	.4775-
.900	706.52	8.54	3.88	.3111	.0137	.5359-	.3245-	.0904-	.6636-
.950	744.67	2.13-	3.99	.3139	.0339	.4549-	.0627	.0192-	.2117
.950	744.67	.00	3.98	.3157	.0355	.4558-	.0156-	.0306-	.0418
.950	744.67	2.15	3.98	.3153	.0330	.4596-	.1004-	.0439-	.1431-
.950	744.67	4.28	3.95	.3175	.0264	.4793-	.1843-	.0596-	.3174-
.950	744.67	6.43	3.90	.3123	.0173	.5167-	.2680-	.0737-	.4975-

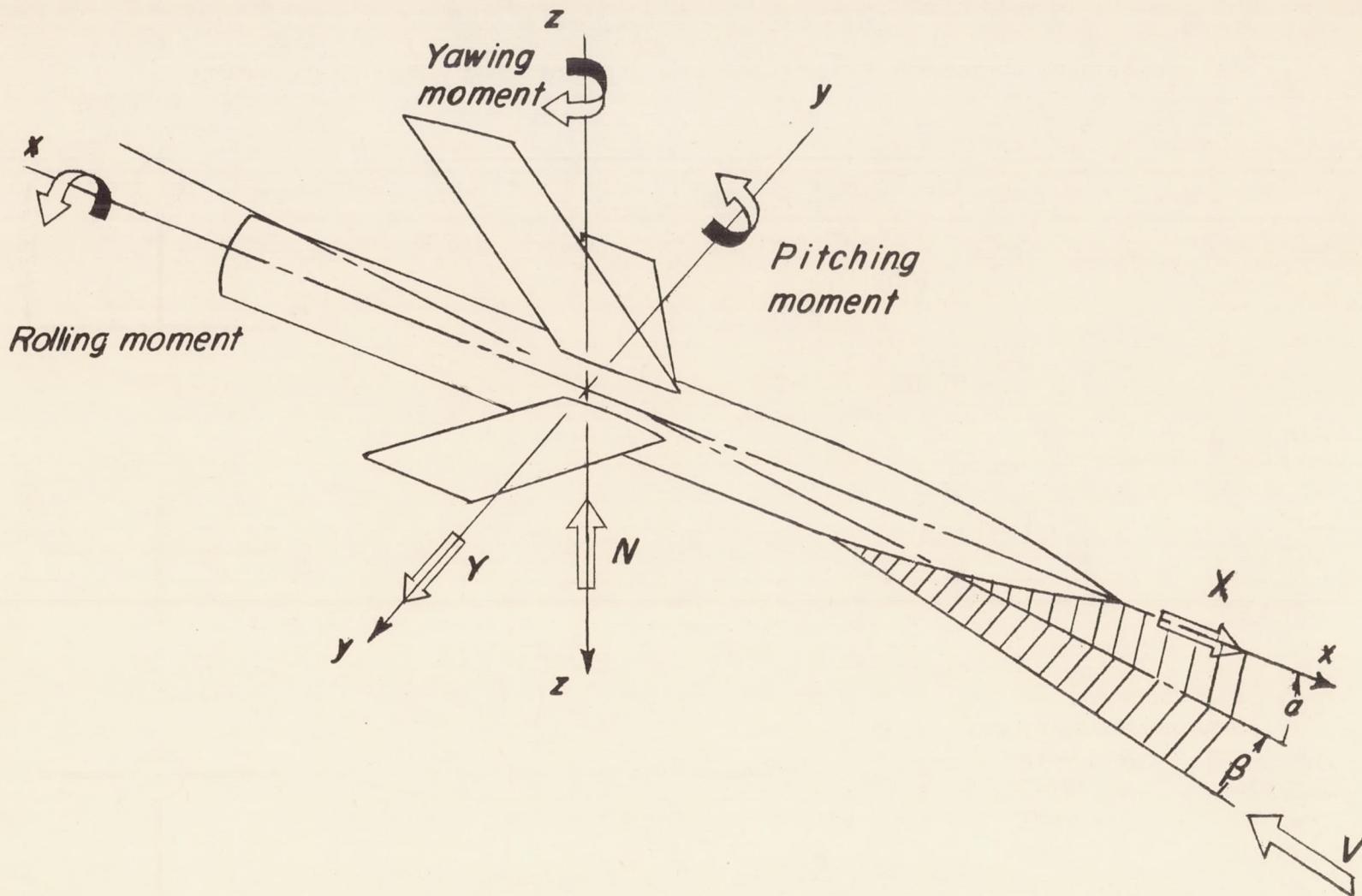
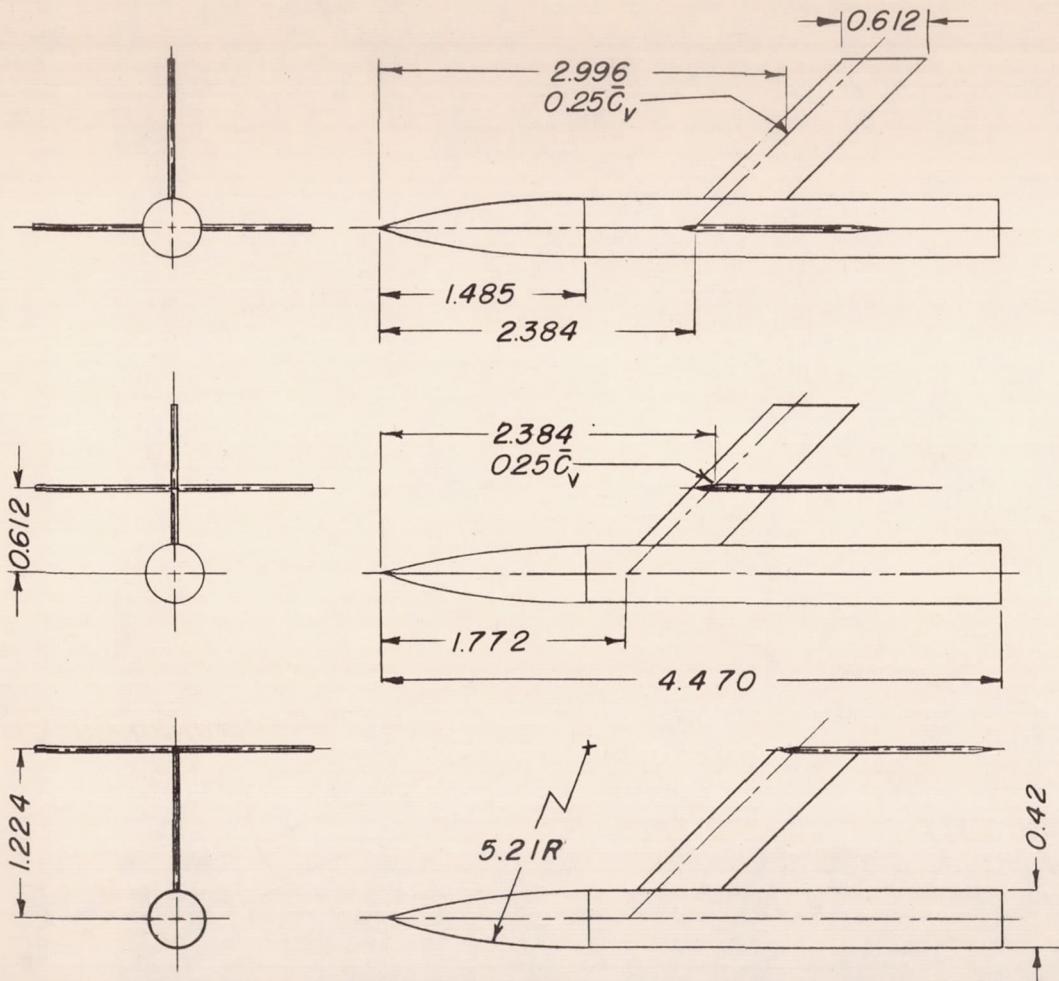


Figure 1.- System of axes used. Positive forces, moments, angles, and velocities are indicated by arrows.



PHYSICAL CHARACTERISTICS

Vertical tail

Area	0.75 sq ft
Span	1.224 ft
Chord	0.612 ft
Aspect ratio	2.0
Airfoil section normal to leading edge	65 A 010
Sweep	45°

Horizontal tail

Area	1.00 sq ft
Span	2.000 ft
Chord	0.500 ft
Aspect ratio	4.0
Airfoil section normal to leading edge	65 A 010
Sweep	45°

Figure 2.- Physical characteristics of model. All dimensions in feet unless otherwise noted.



L-83800

Figure 3.- Photograph of model in the Langley high-speed 7- by 10-foot tunnel. $h/b_V = 0$.

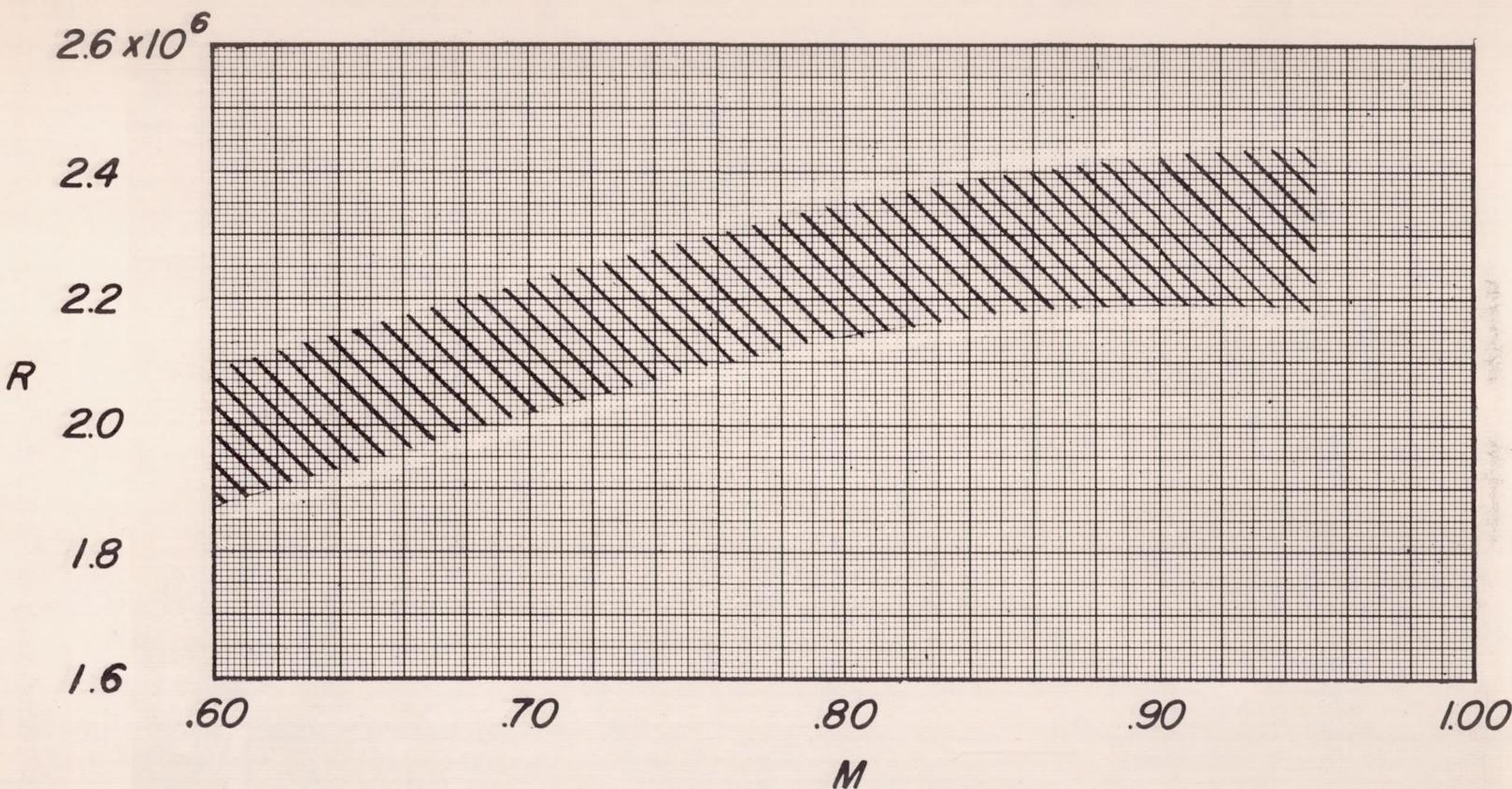
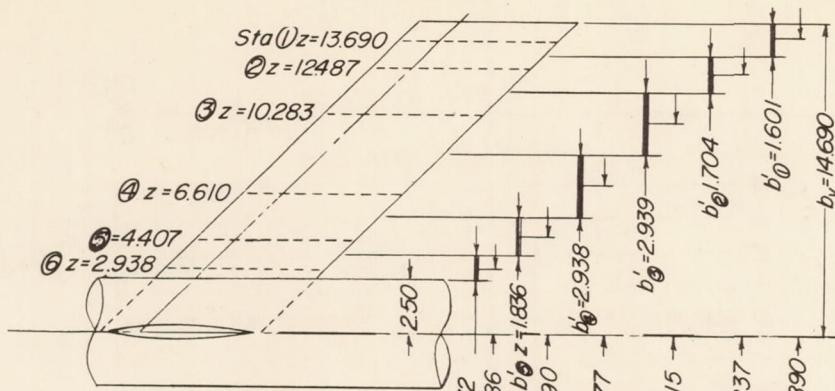
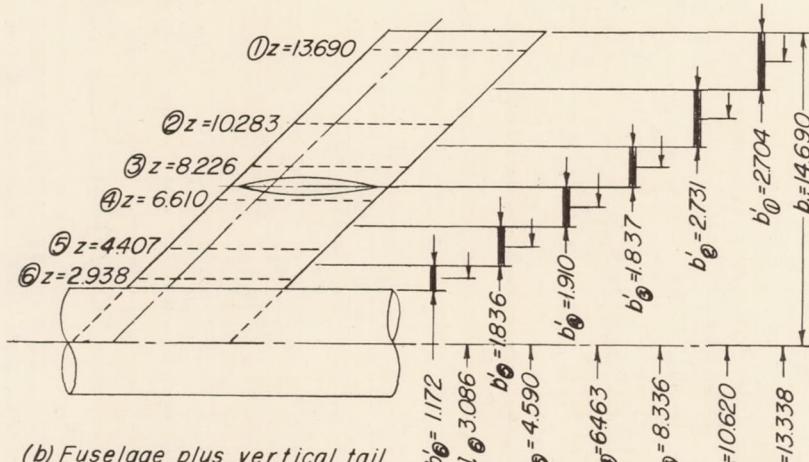


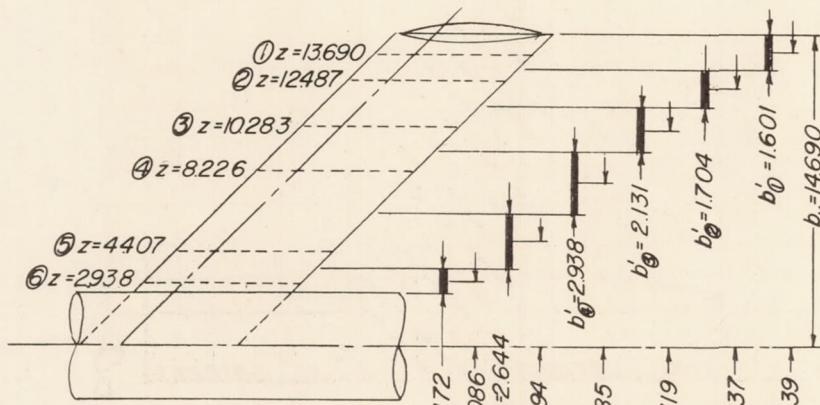
Figure 4.- Variation of test Reynolds number with Mach number. (Reynolds number is based on the mean aerodynamic chord of the vertical tail.)



(a) Fuselage plus vertical tail
with and without horizontal
tail at 0.0 b_v .



(b) Fuselage plus vertical tail
with horizontal tail at
0.50 b_v .



(c) Fuselage plus vertical tail
with horizontal tail at
1.00 b_v .

Figure 5.- Sketch showing "weighting factors" used for spanwise integration of vertical-tail load to determine C_Y and C_l .

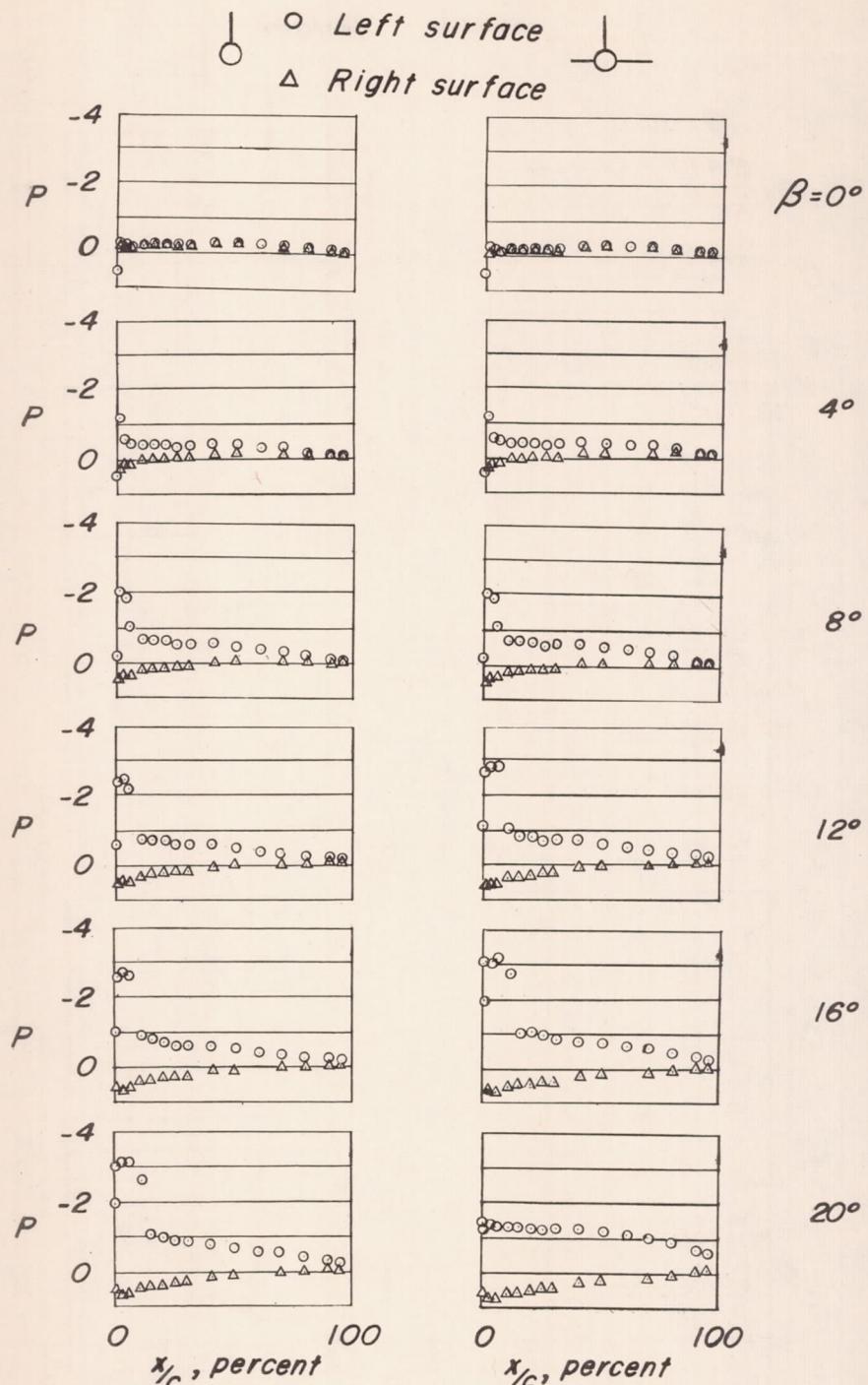
(a) $M = 0.60.$

Figure 6.- Comparisons of the chordwise pressure distributions at station $0.200b_v$ of the vertical tail for fuselage—vertical-tail combination with and without the horizontal tail at $0b_v$. $\alpha = 0^\circ$.

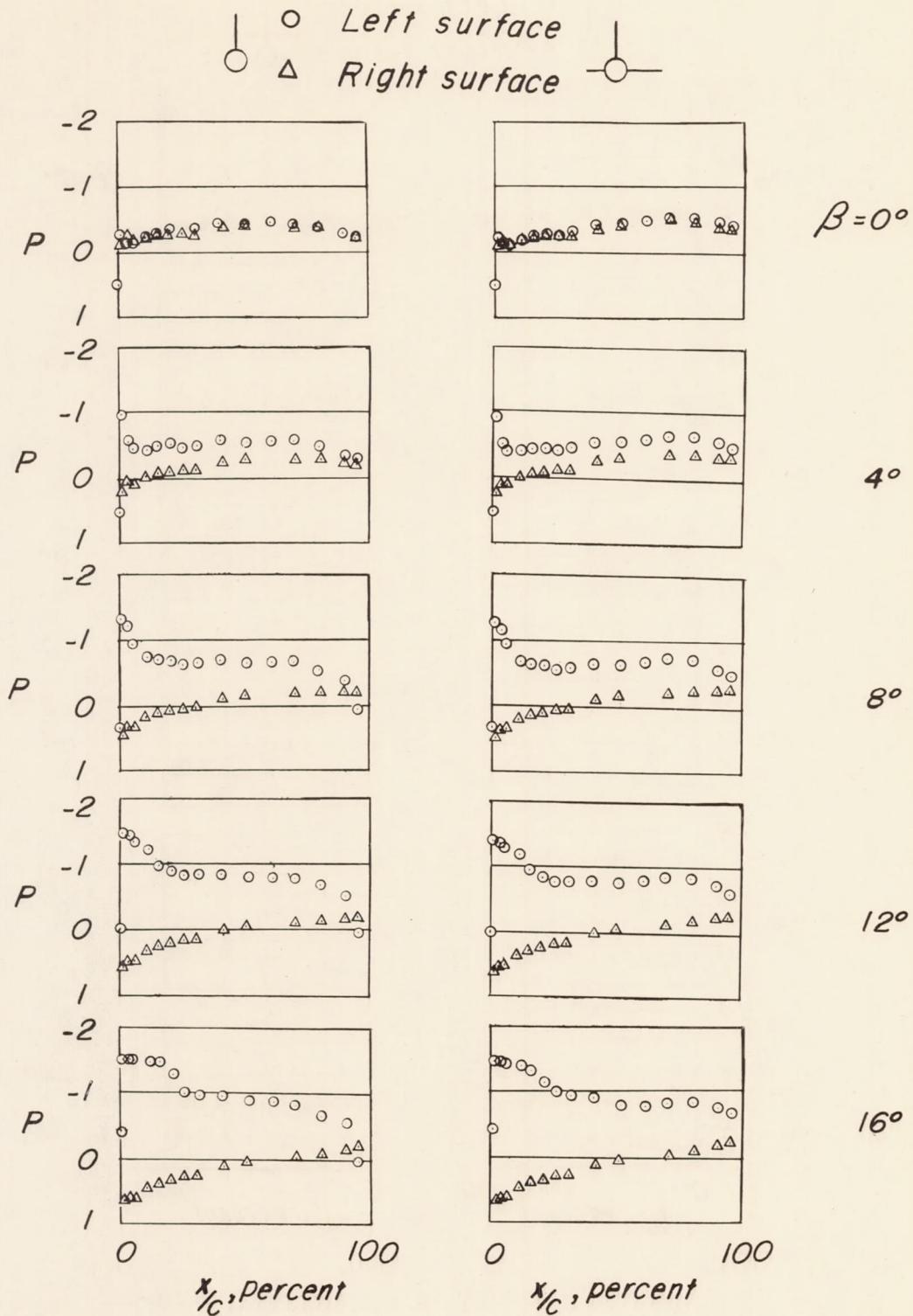
(b) $M = 0.95$.

Figure 6.- Concluded.

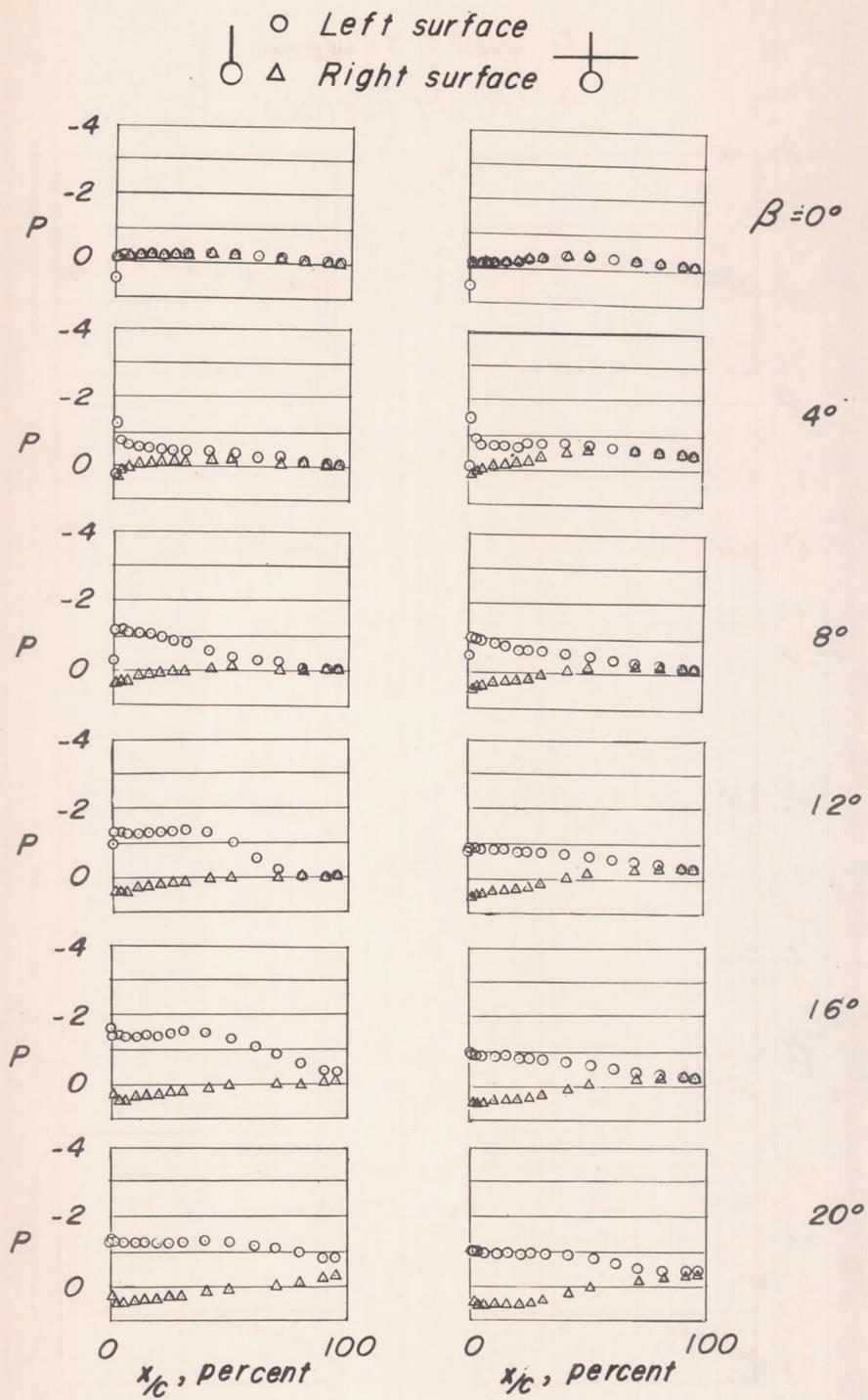
(a) $M = 0.60.$

Figure 7.- Comparisons of the chordwise pressure distributions at station $0.450b_v$ of the vertical tail for fuselage—vertical-tail combination with and without the horizontal tail at $0.50b_v$. $\alpha = 0^\circ$.

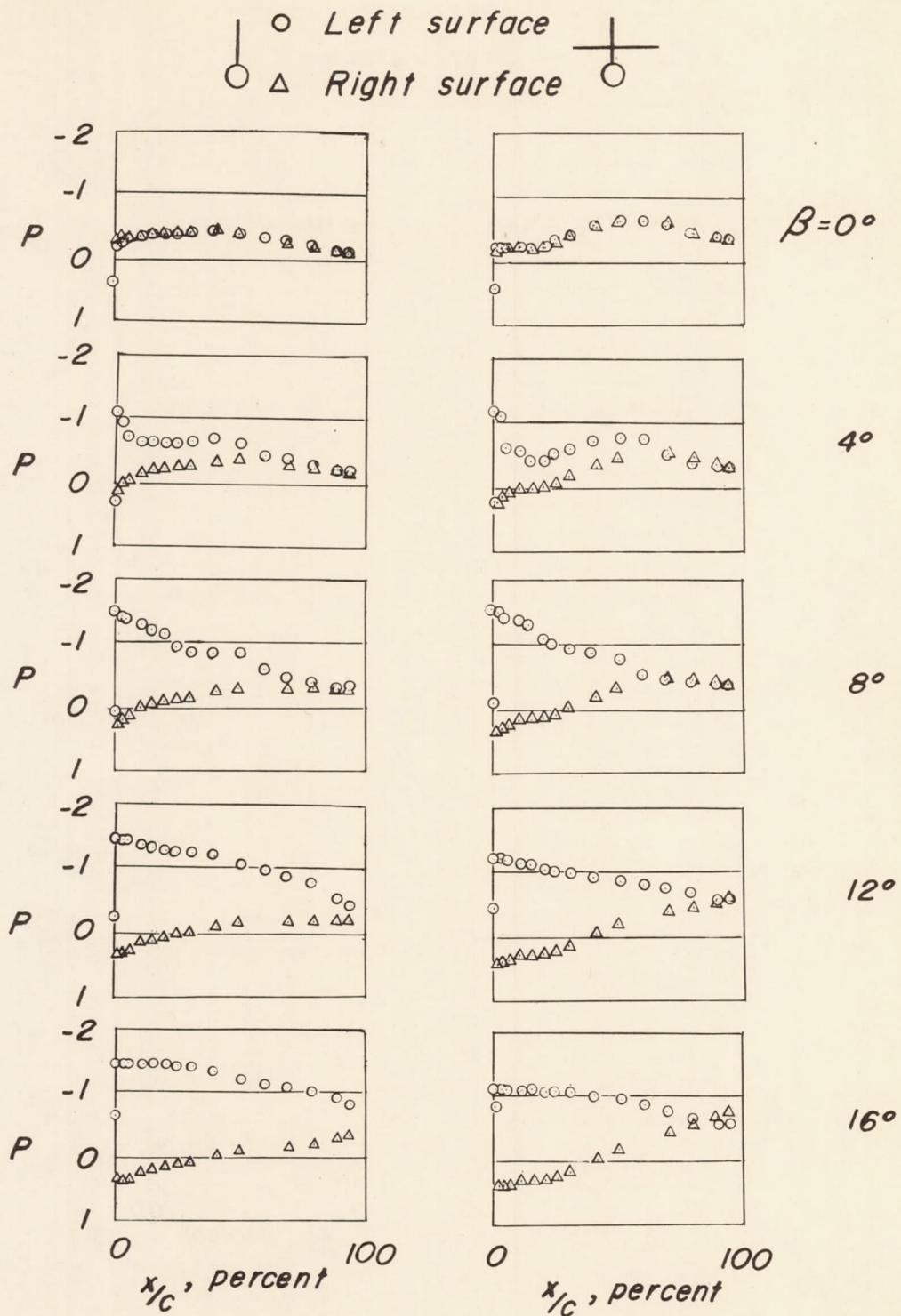
(b) $M = 0.95.$

Figure 7.- Concluded.

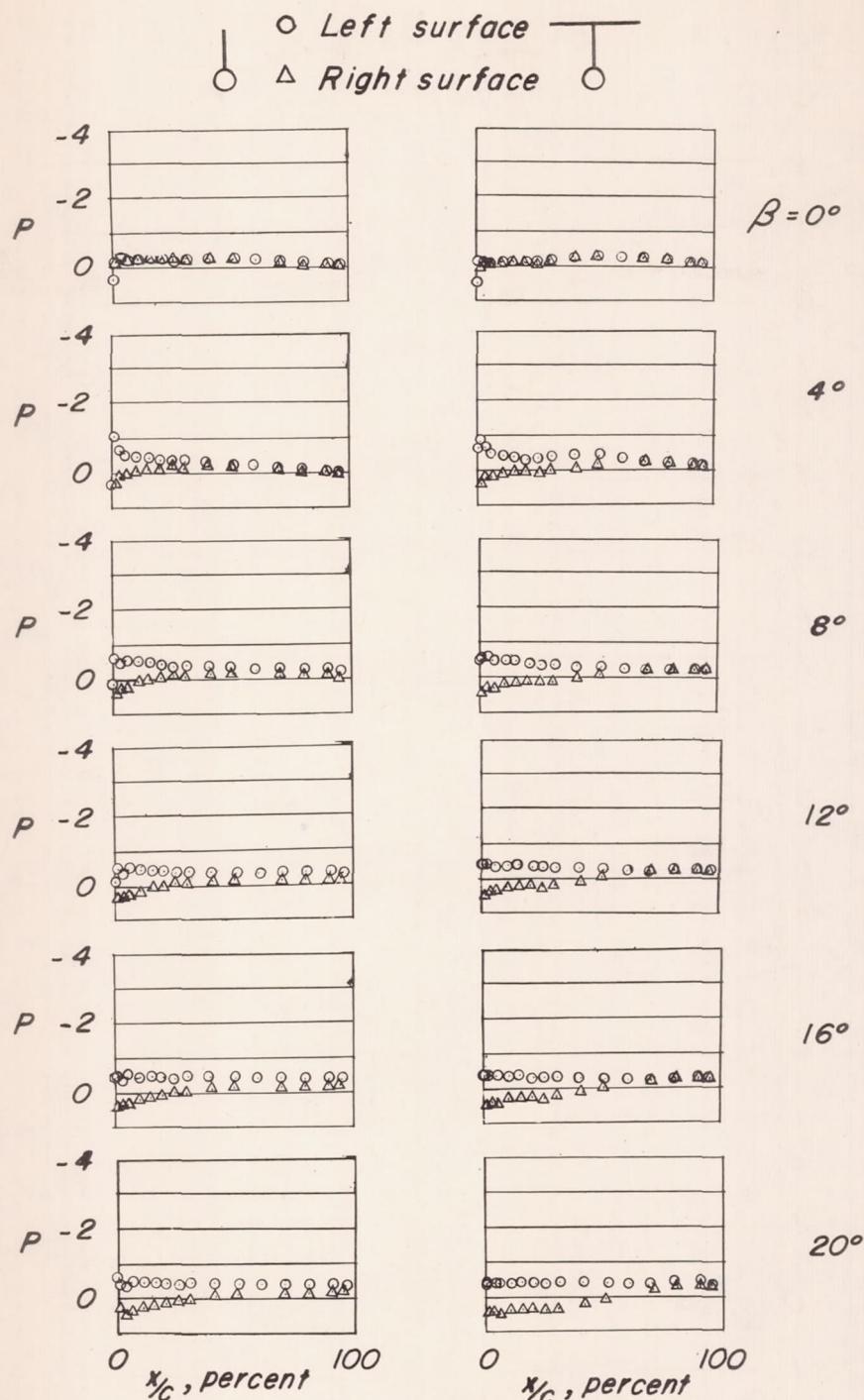
(a) $M = 0.60.$

Figure 8.- Comparisons of the chordwise pressure distributions at station 0.93l_{by} of the vertical tail for fuselage—vertical-tail combination with and without the horizontal tail at 1.0b_y. $\alpha = 0^\circ$.

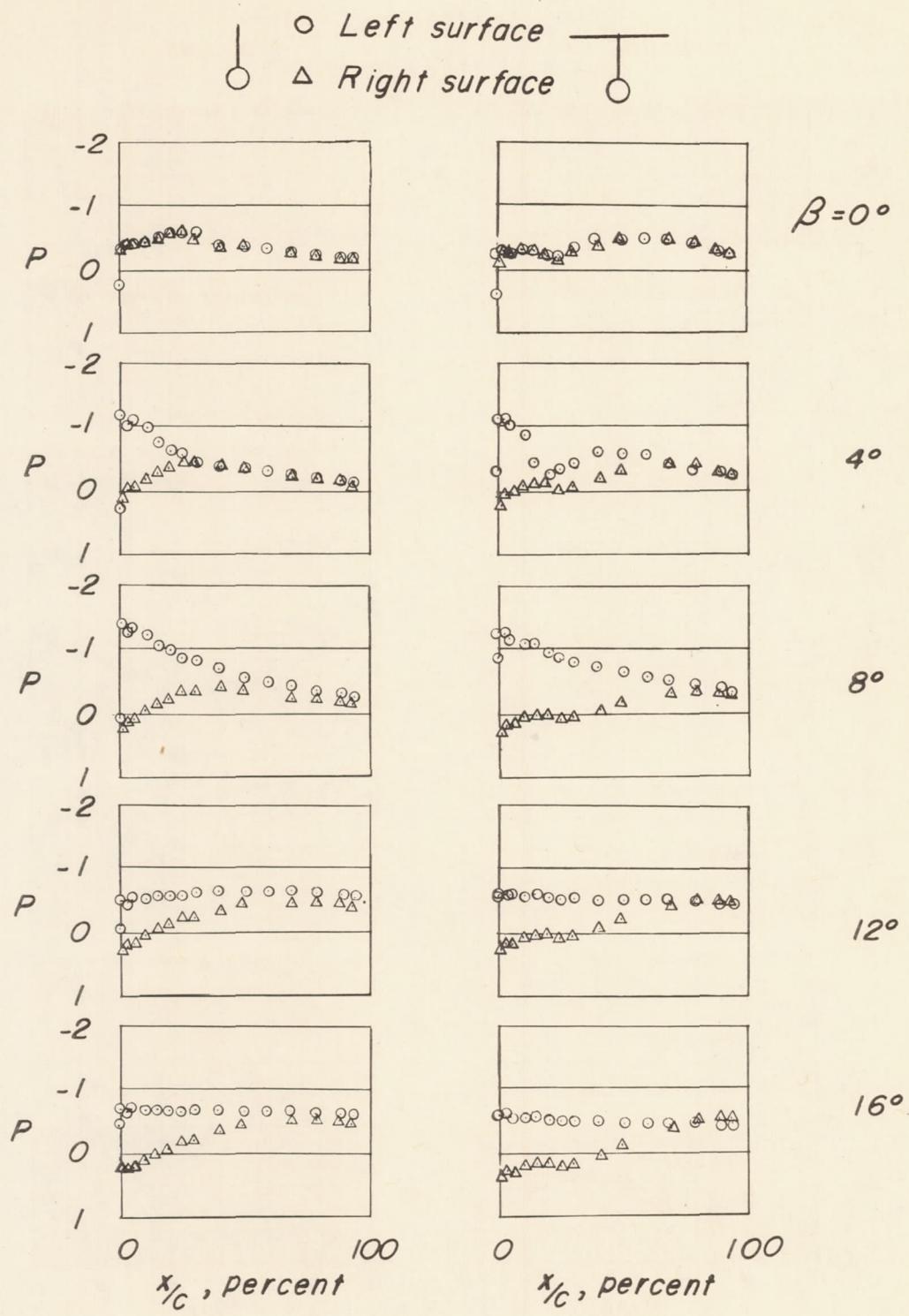
(b) $M = 0.95$.

Figure 8.- Concluded.

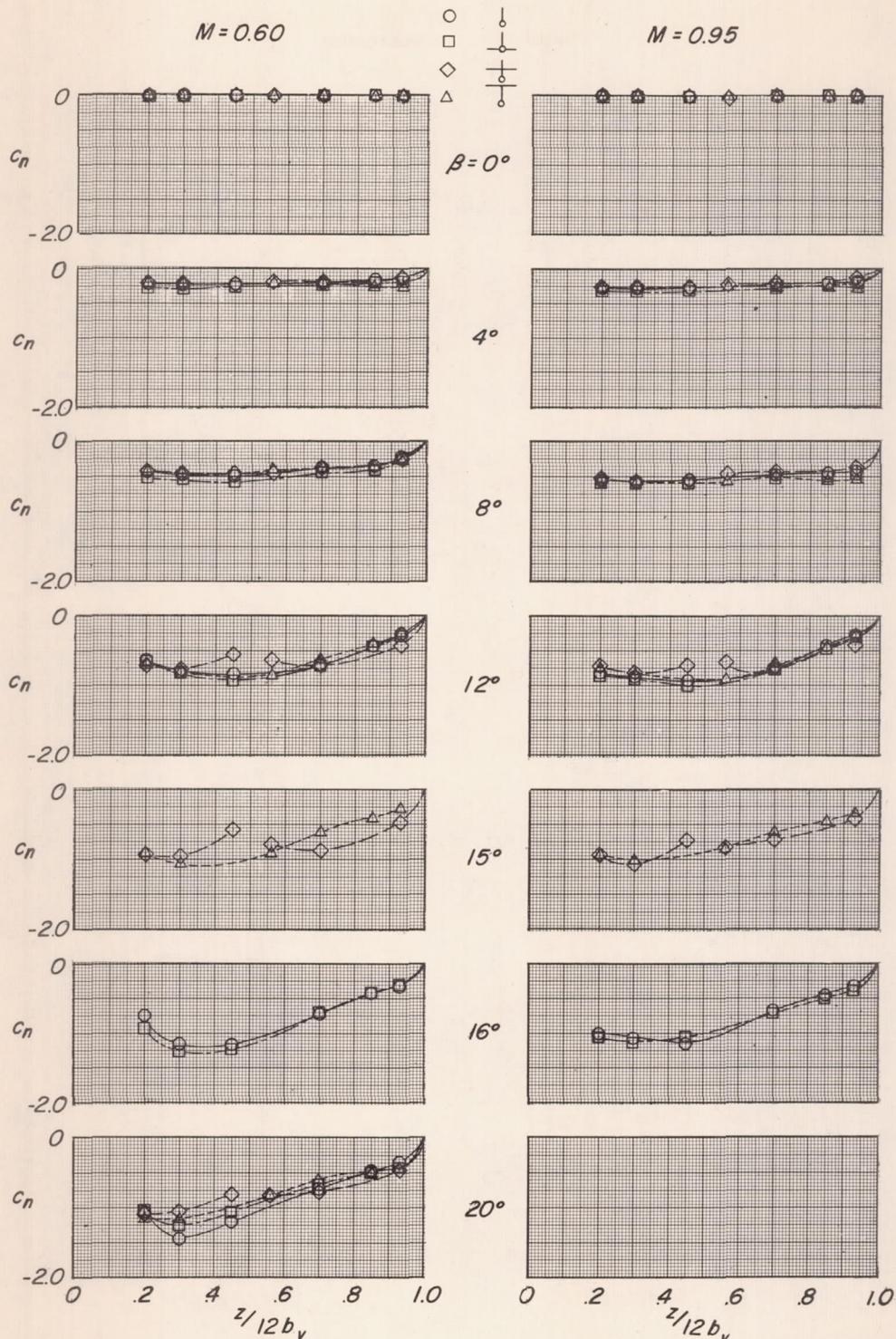
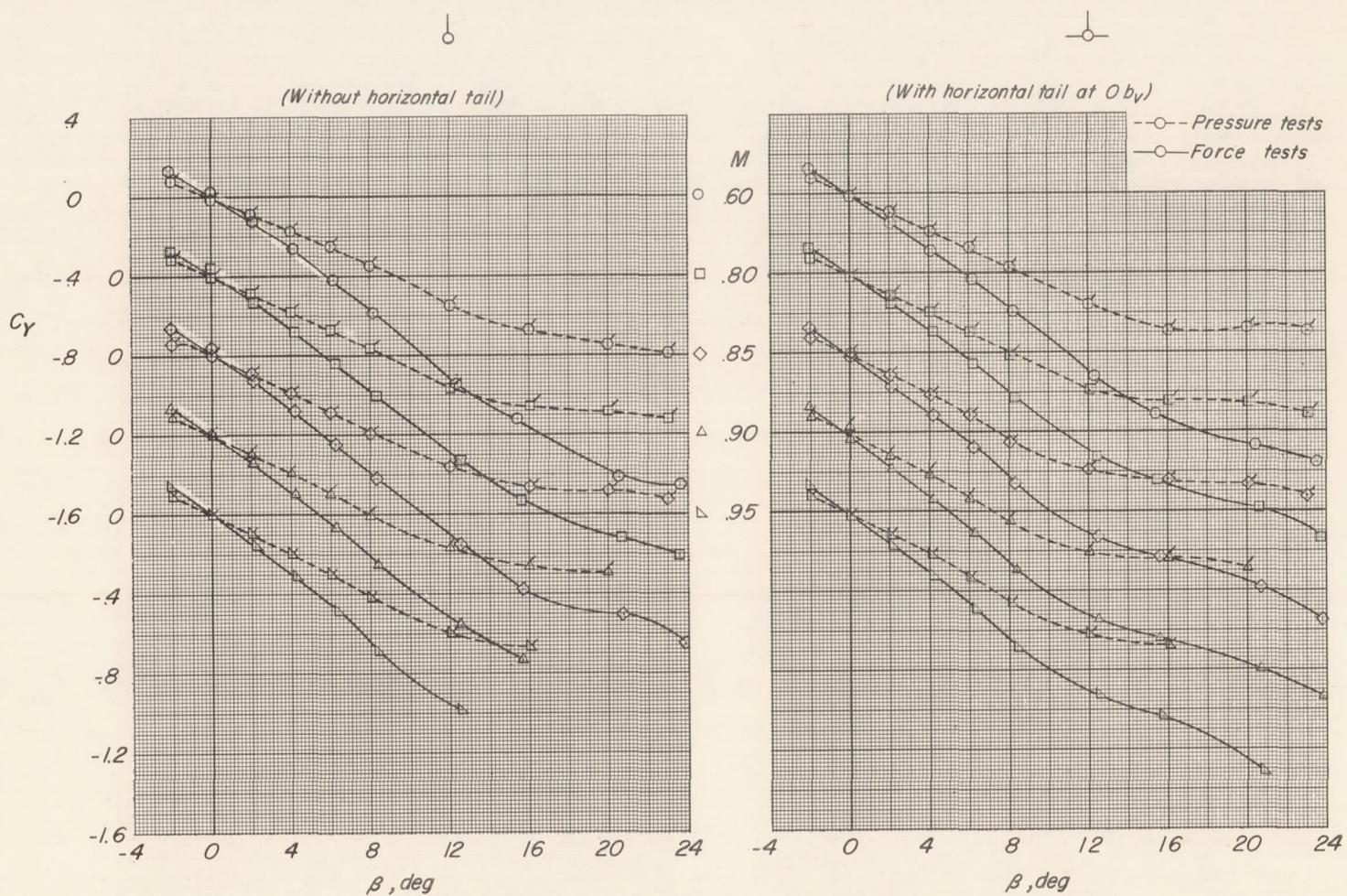


Figure 9.- The variation of c_n over the span of the vertical tail for fuselage—vertical-tail combinations with and without the horizontal tail at $0b_v$, $0.5b_v$, and $1.0b_v$. $\alpha = 0^\circ$; $M = 0.60$ and 0.95 .

(a) Fuselage plus vertical tail with and without horizontal tail at Ob_v .Figure 10.- The variation of C_Y with β at various Mach numbers. $\alpha = 0^\circ$.

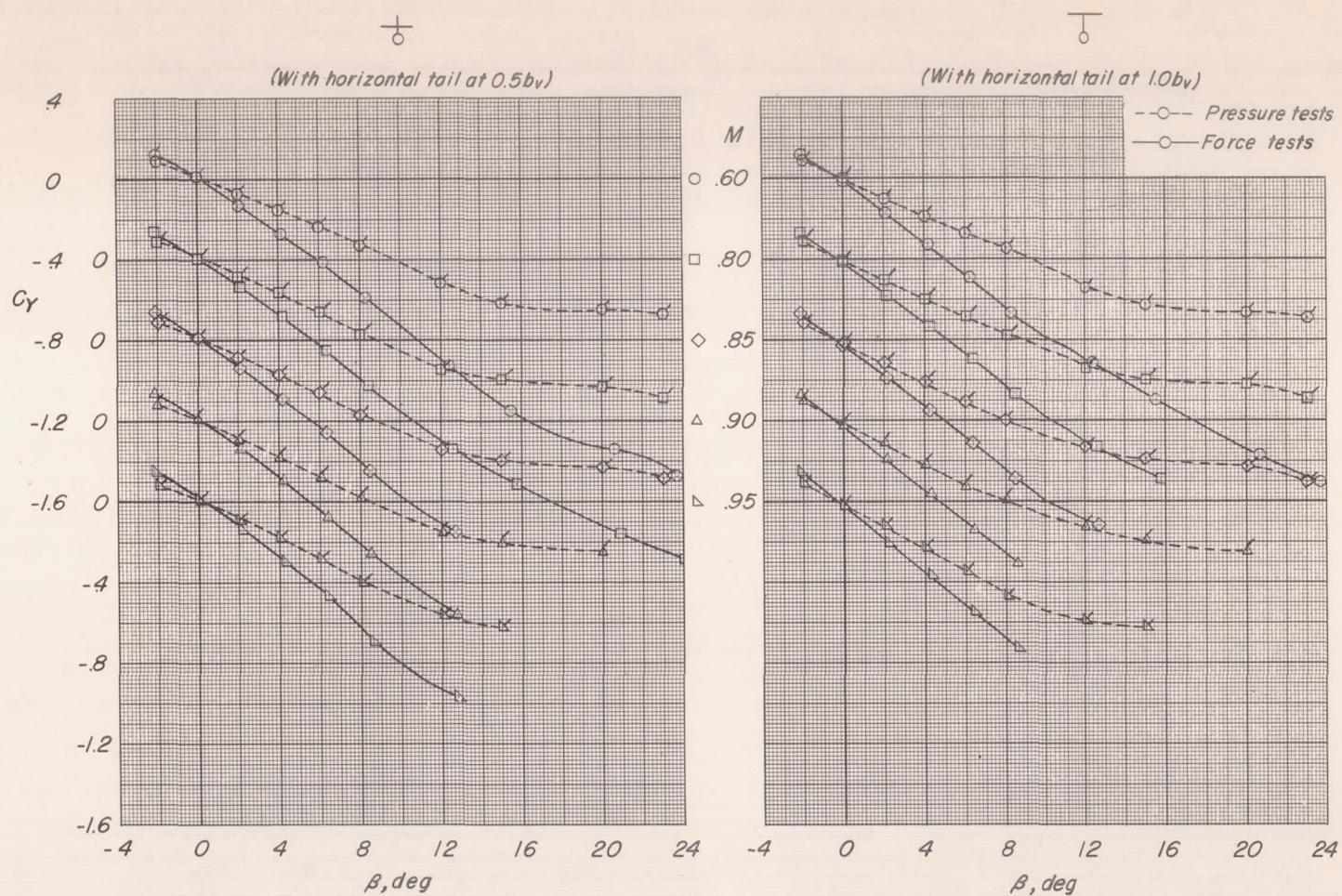
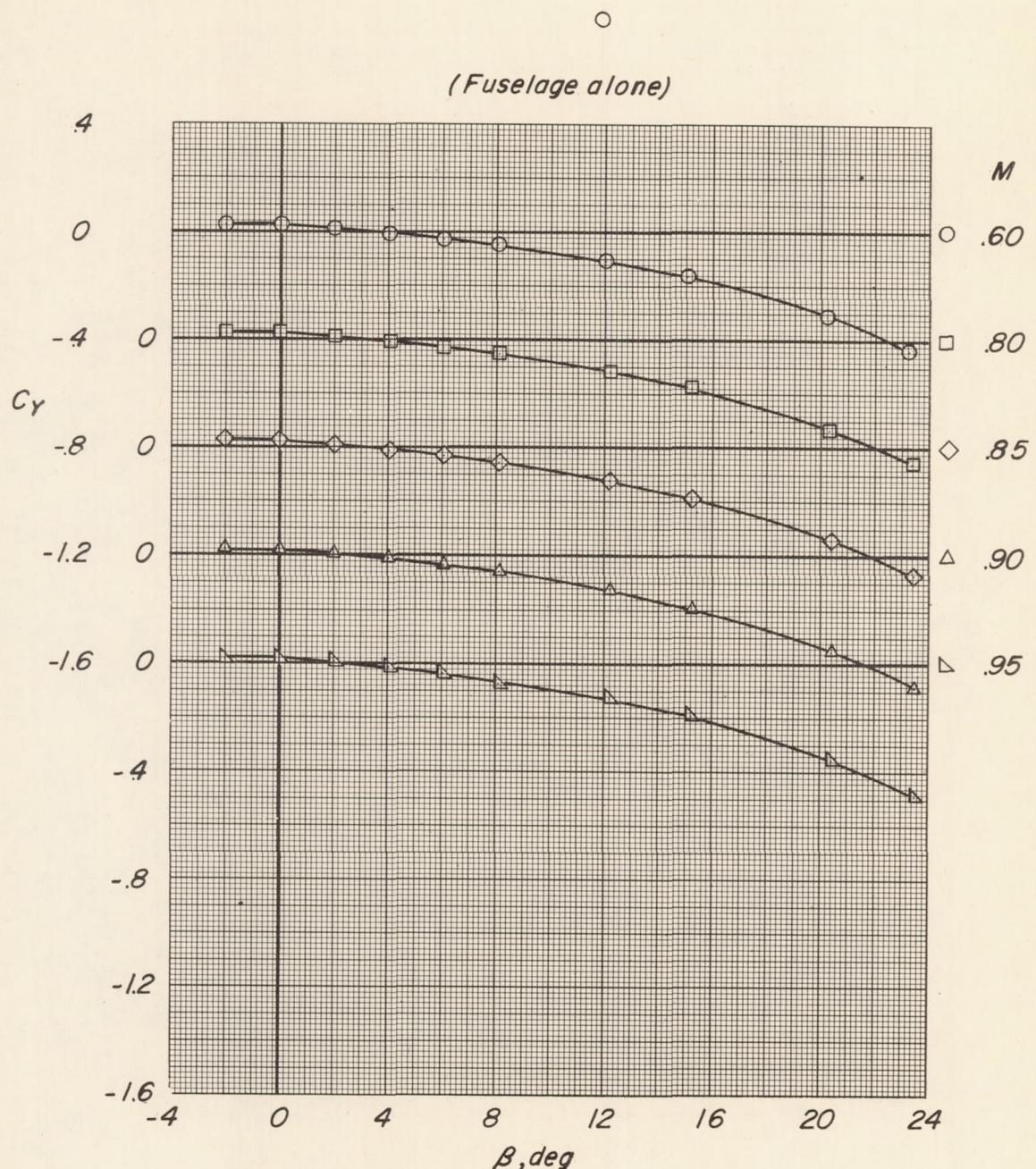
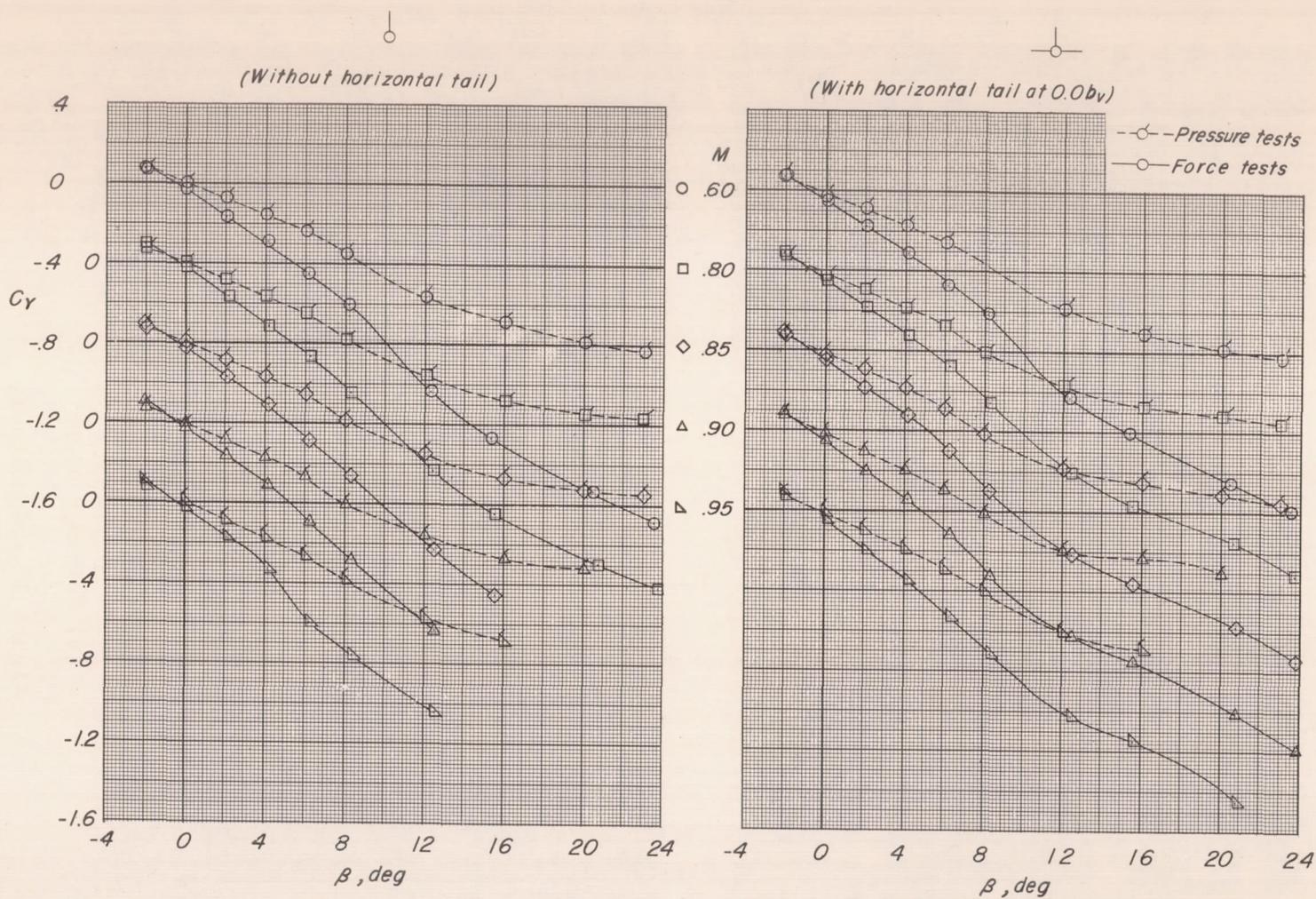
(b) Fuselage plus vertical tail with horizontal tail at $0.5b_v$ and $1.0b_v$.

Figure 10.- Continued.



(c) Fuselage alone.

Figure 10.- Concluded.

(a) Fuselage plus vertical tail with and without horizontal tail at $0b_v$.Figure 11.- The variation of C_Y with β at various Mach numbers. $\alpha = 4^\circ$.

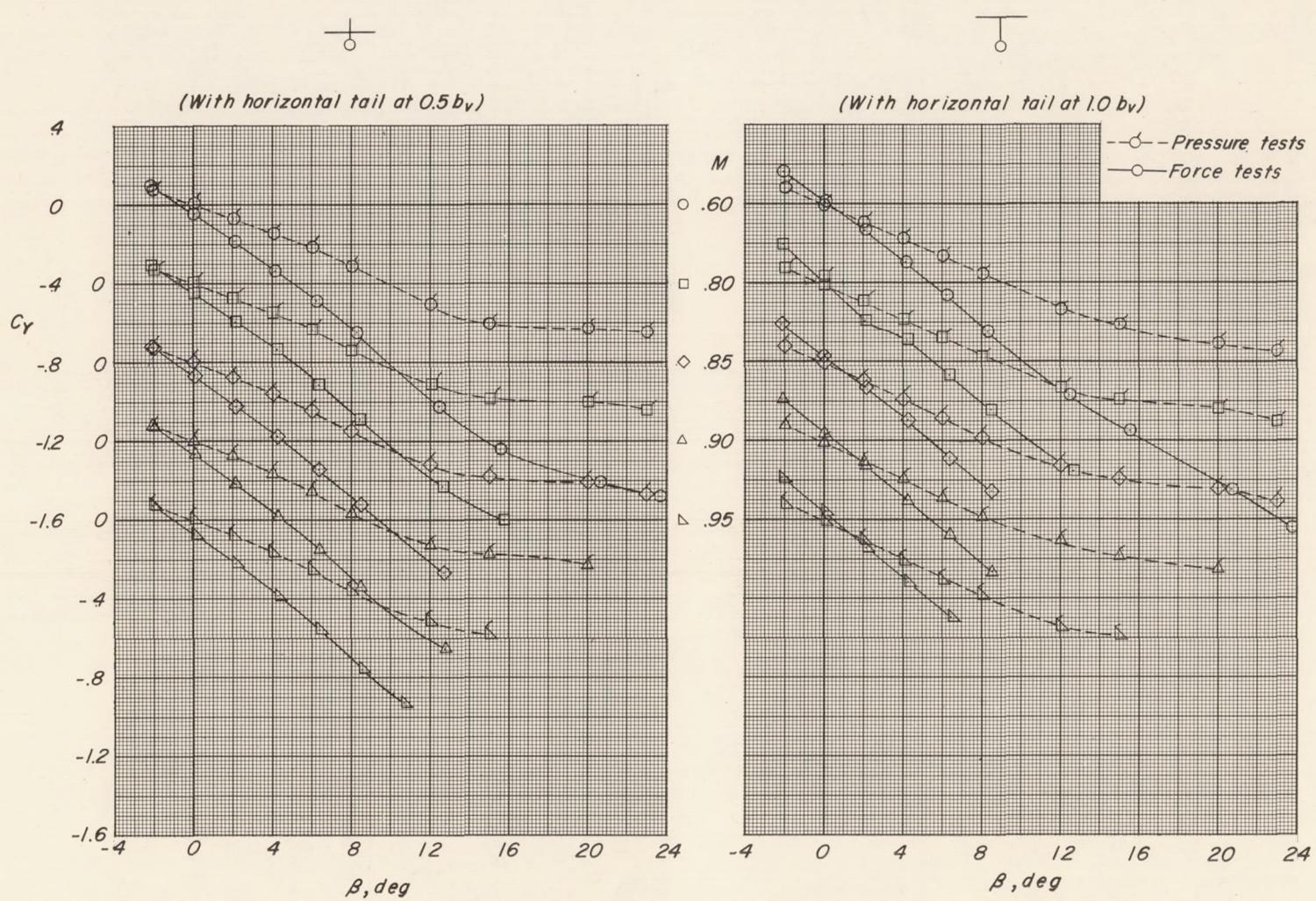
(b) Fuselage plus vertical tail with horizontal tail at $0.5 b_v$ and $1.0 b_v$.

Figure 11.- Concluded.

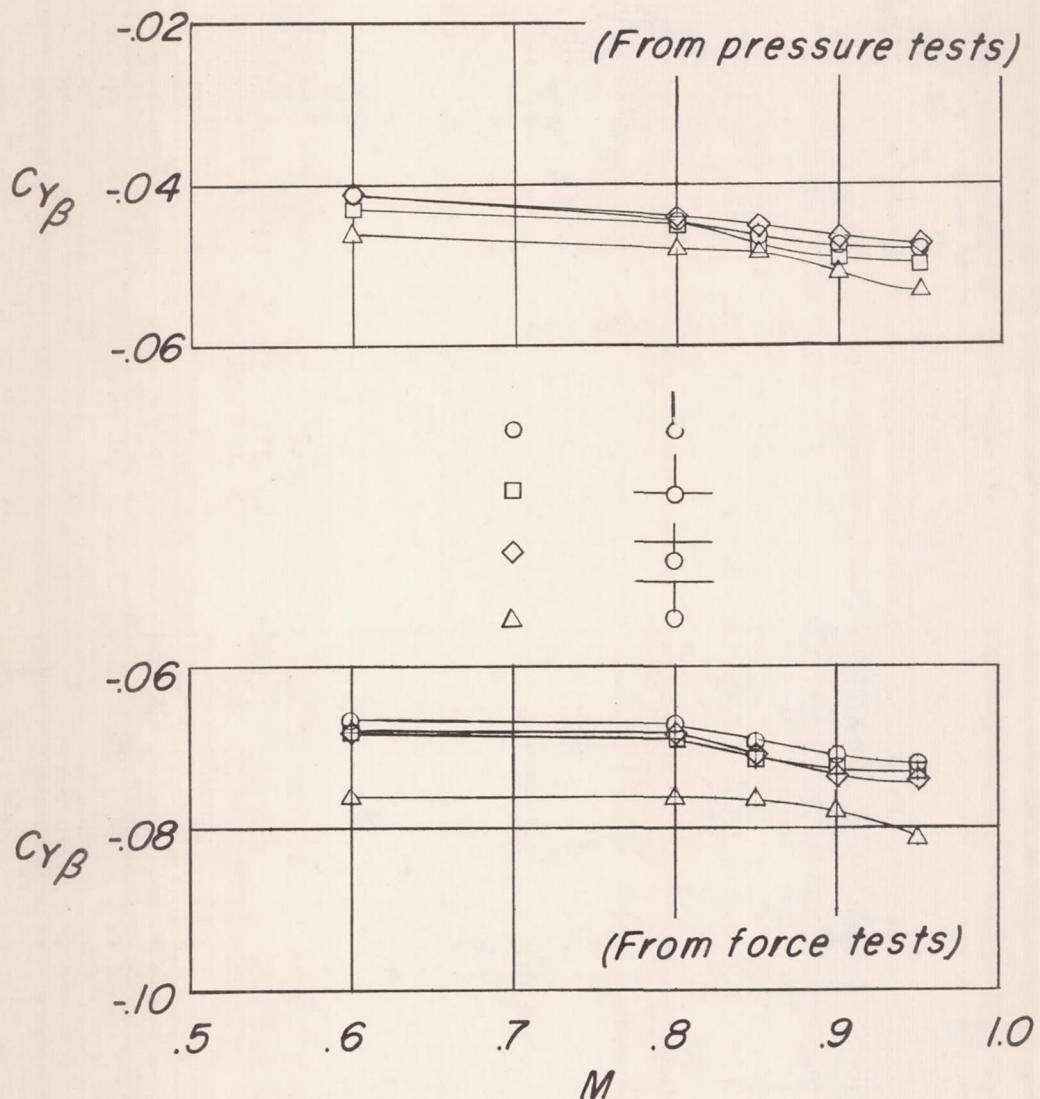


Figure 12.- The variation of $C_{Y\beta}$ with M . $\alpha = 0^\circ$.

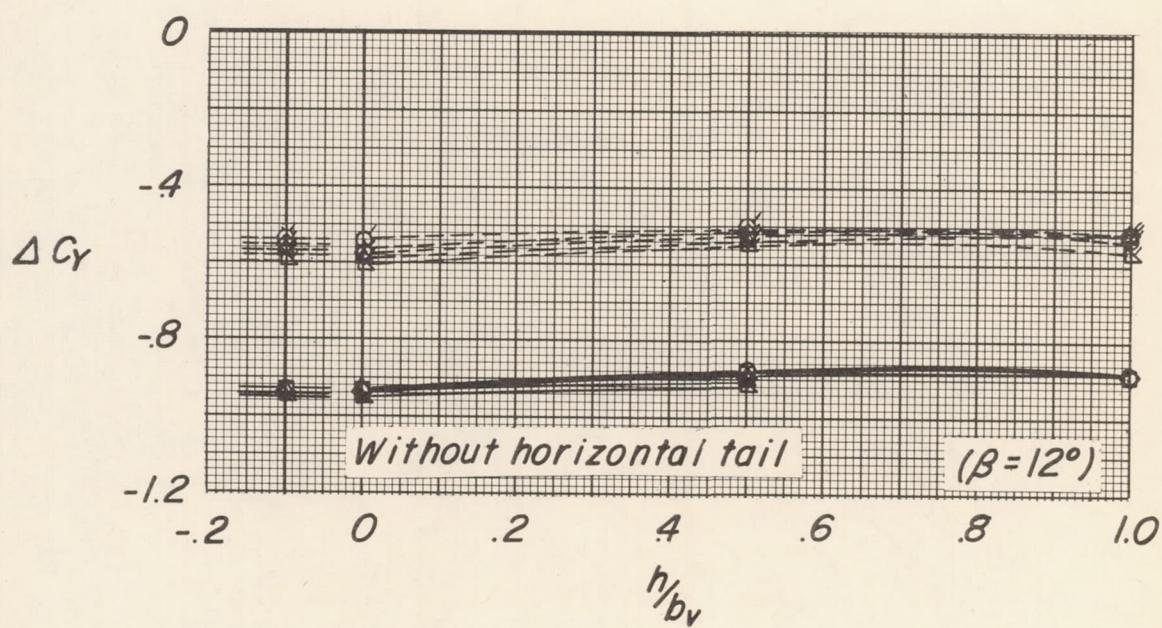
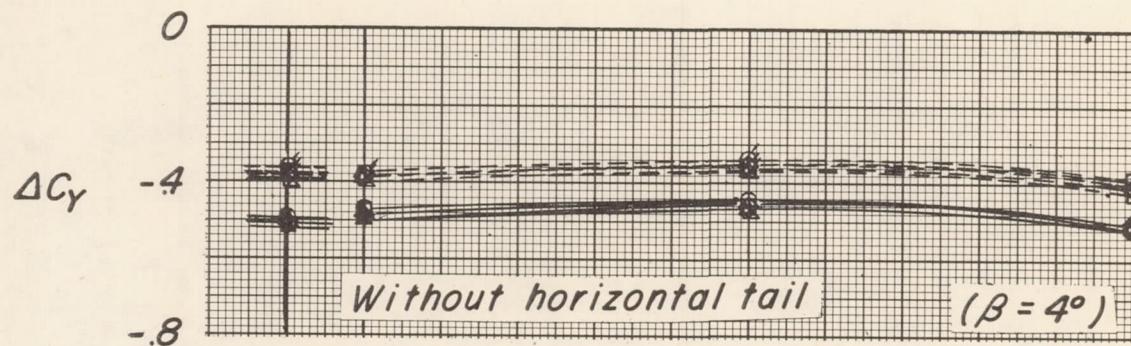
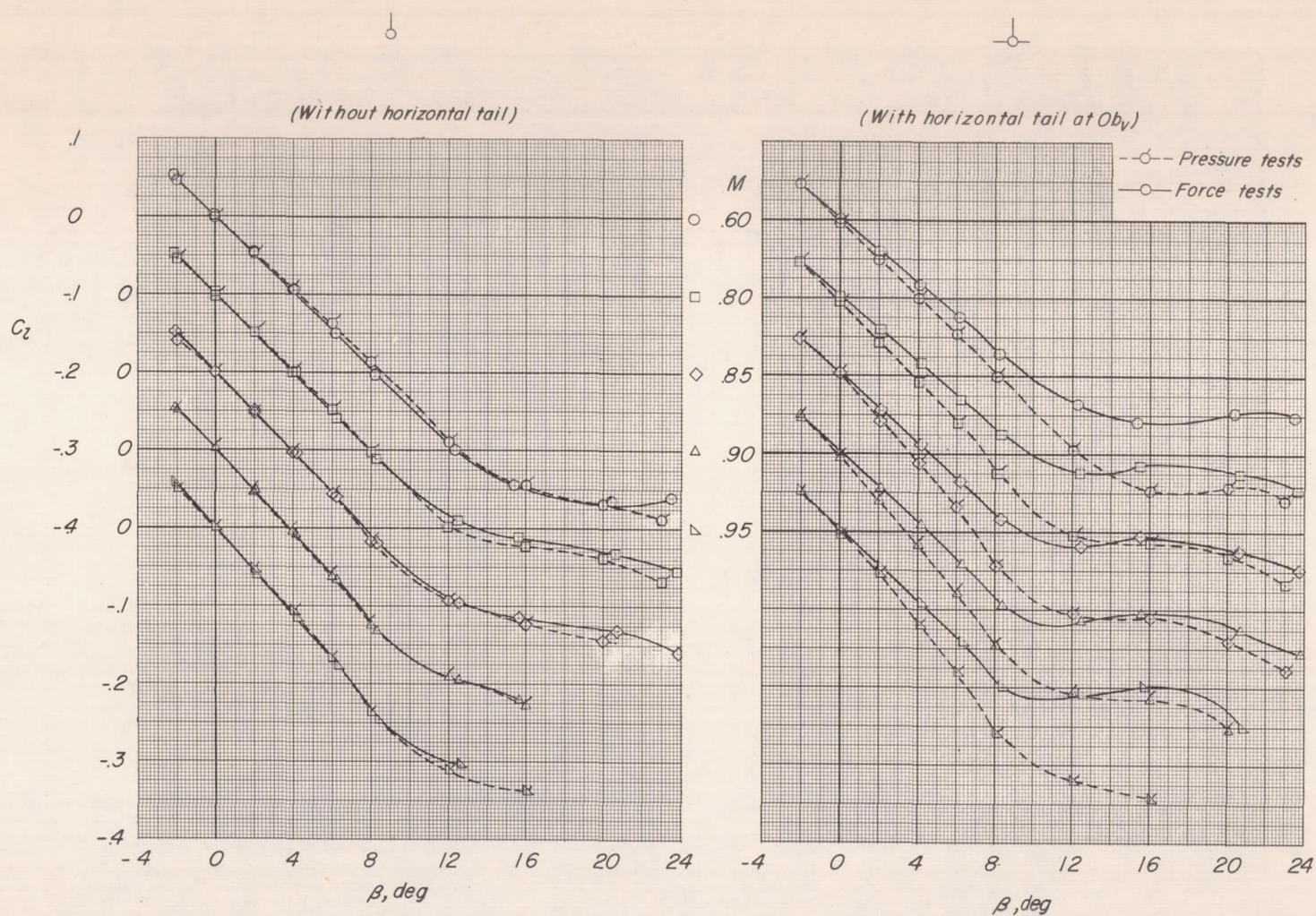
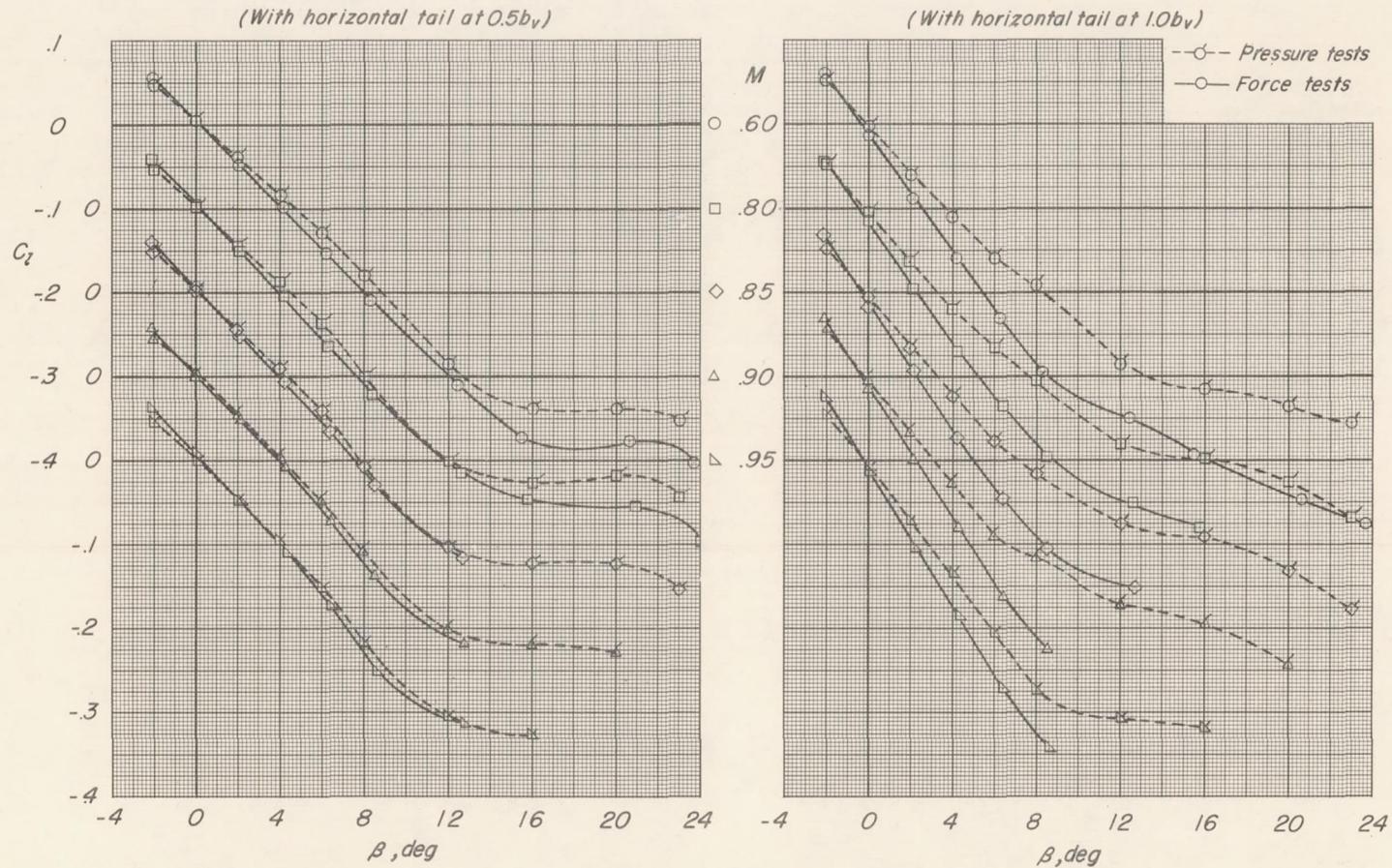


Figure 13.- The variation of ΔC_y with horizontal-tail height at $\alpha = 0^\circ$ and $\beta = 4^\circ$ and 12° .

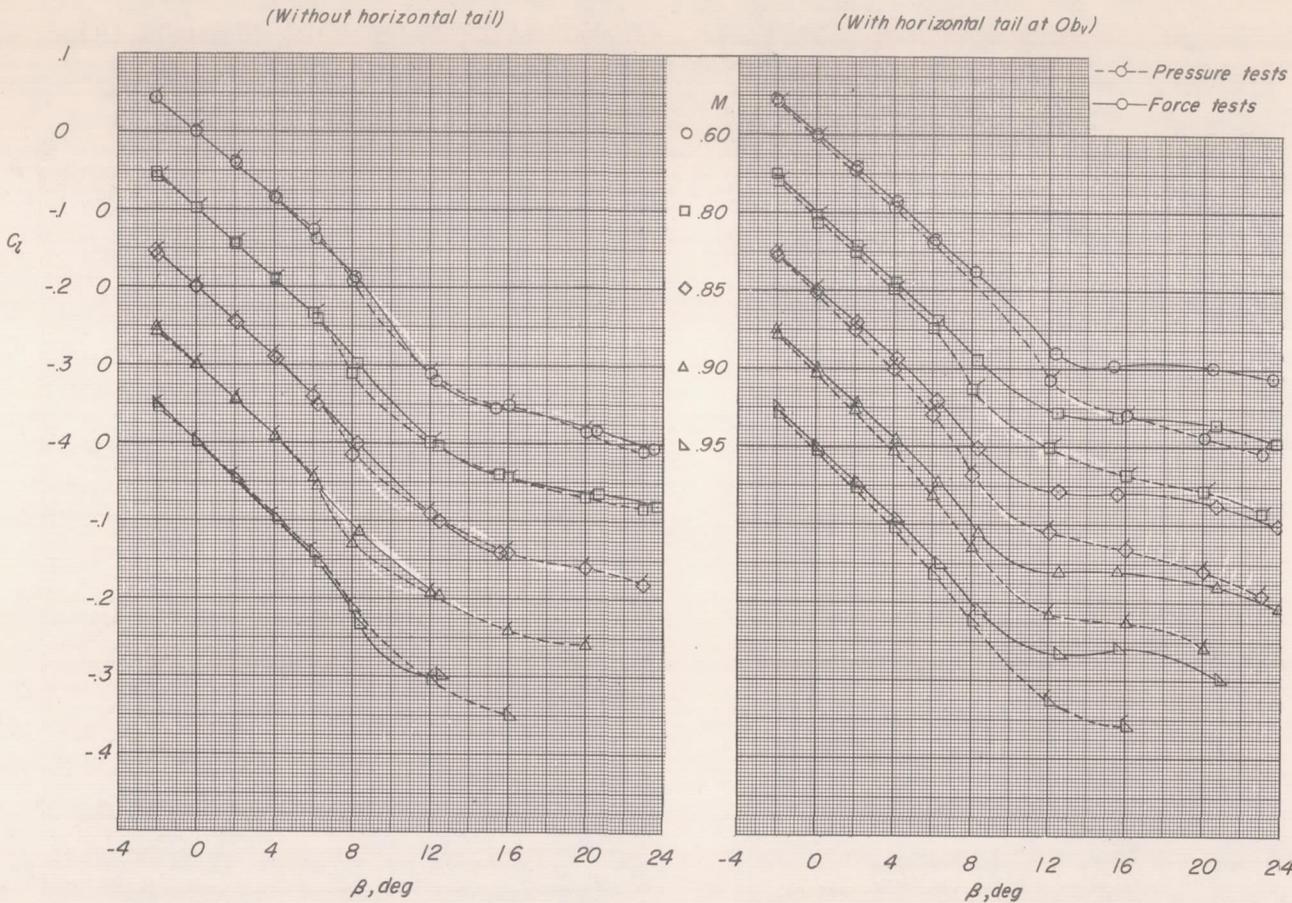
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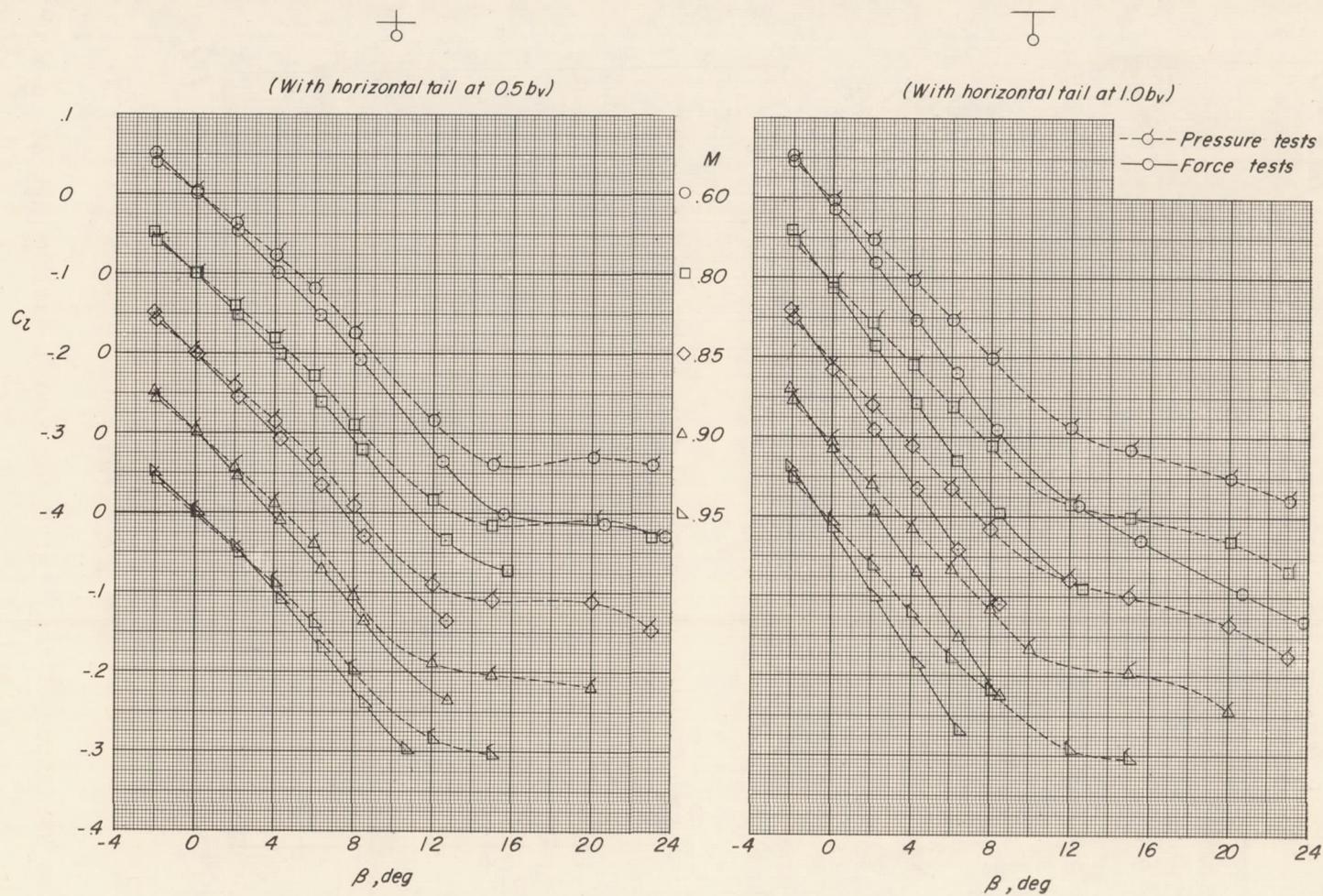
(a) Fuselage plus vertical tail with and without horizontal tail at Ob_v .Figure 14.- The variation of C_l with β at various Mach numbers. $\alpha = 0^\circ$.



(b) Fuselage plus vertical tail with horizontal tail at $0.5b_v$ and $1.0b_v$.

Figure 14.- Concluded.

(a) Fuselage plus vertical tail with and without horizontal tail at Ob_v .Figure 15.- The variation of C_l with β at various Mach numbers. $\alpha = 4^\circ$.



(b) Fuselage plus vertical tail with horizontal tail at $0.5b_v$ and $1.0b_v$.

Figure 15.- Concluded.

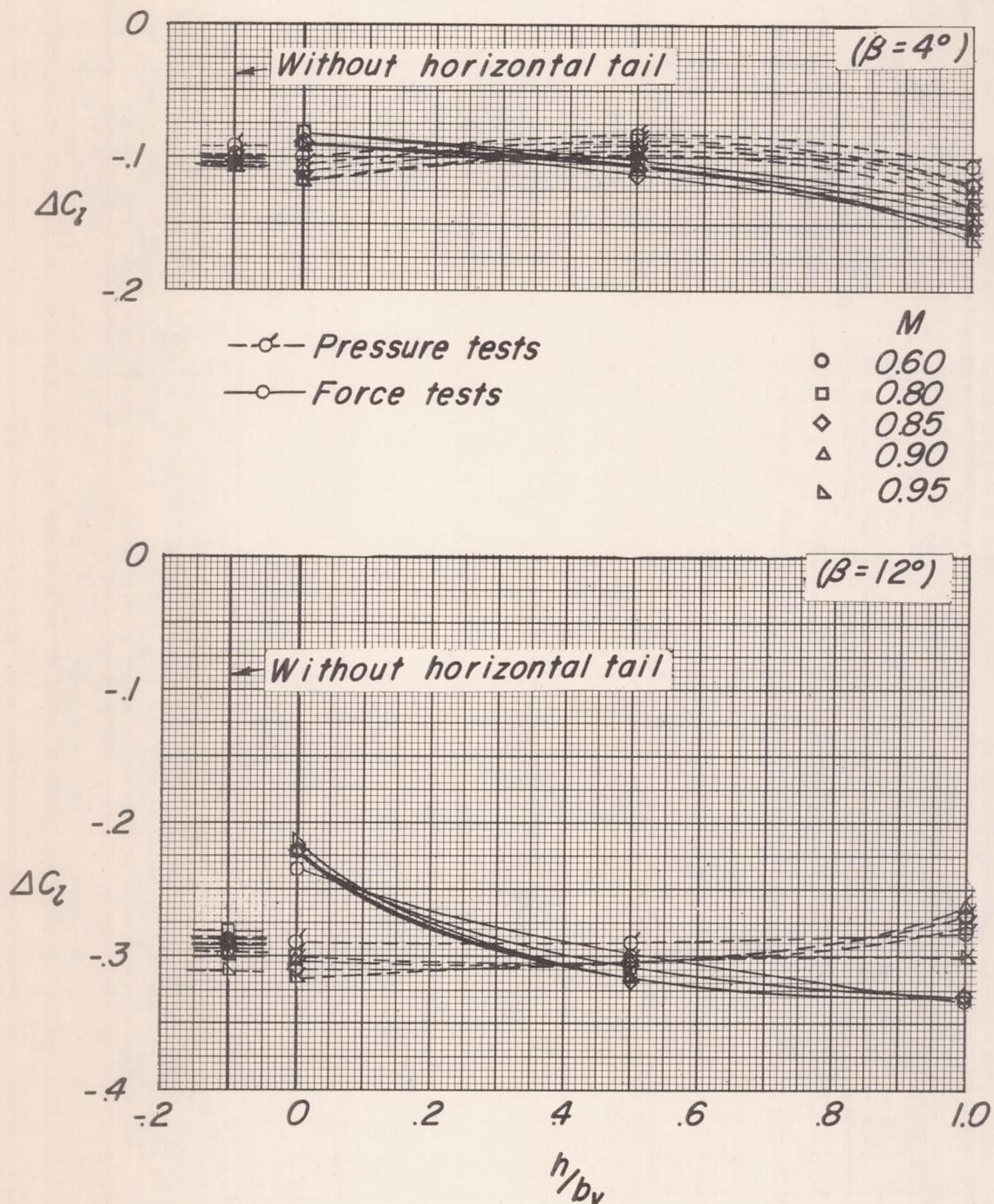


Figure 16.- The variation of ΔC_l with horizontal-tail height at $\alpha = 0^\circ$ and $\beta = 4^\circ$ and 12° .

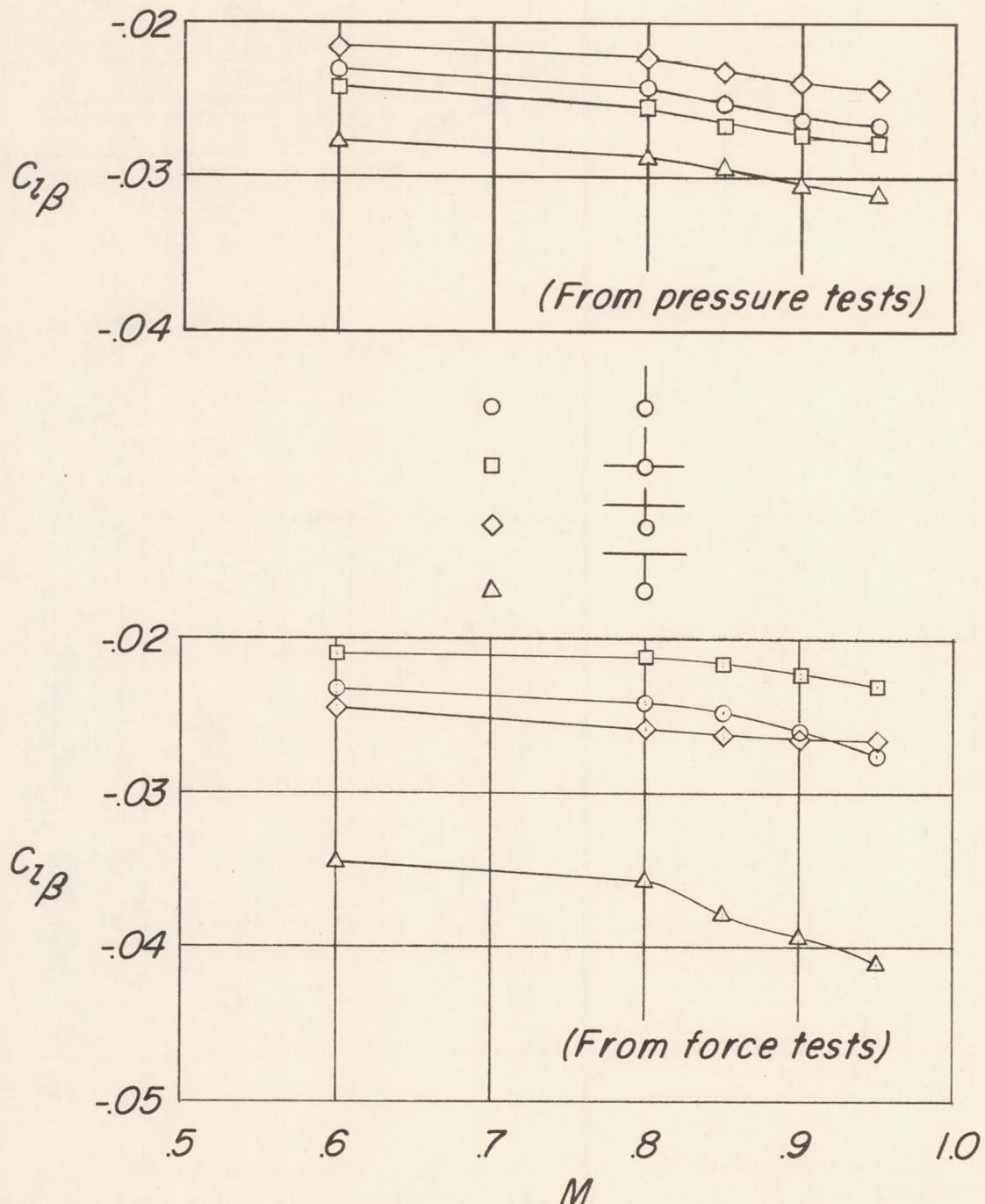


Figure 17.- The variation of $C_{l\beta}$ with M . $\alpha = 0^\circ$.

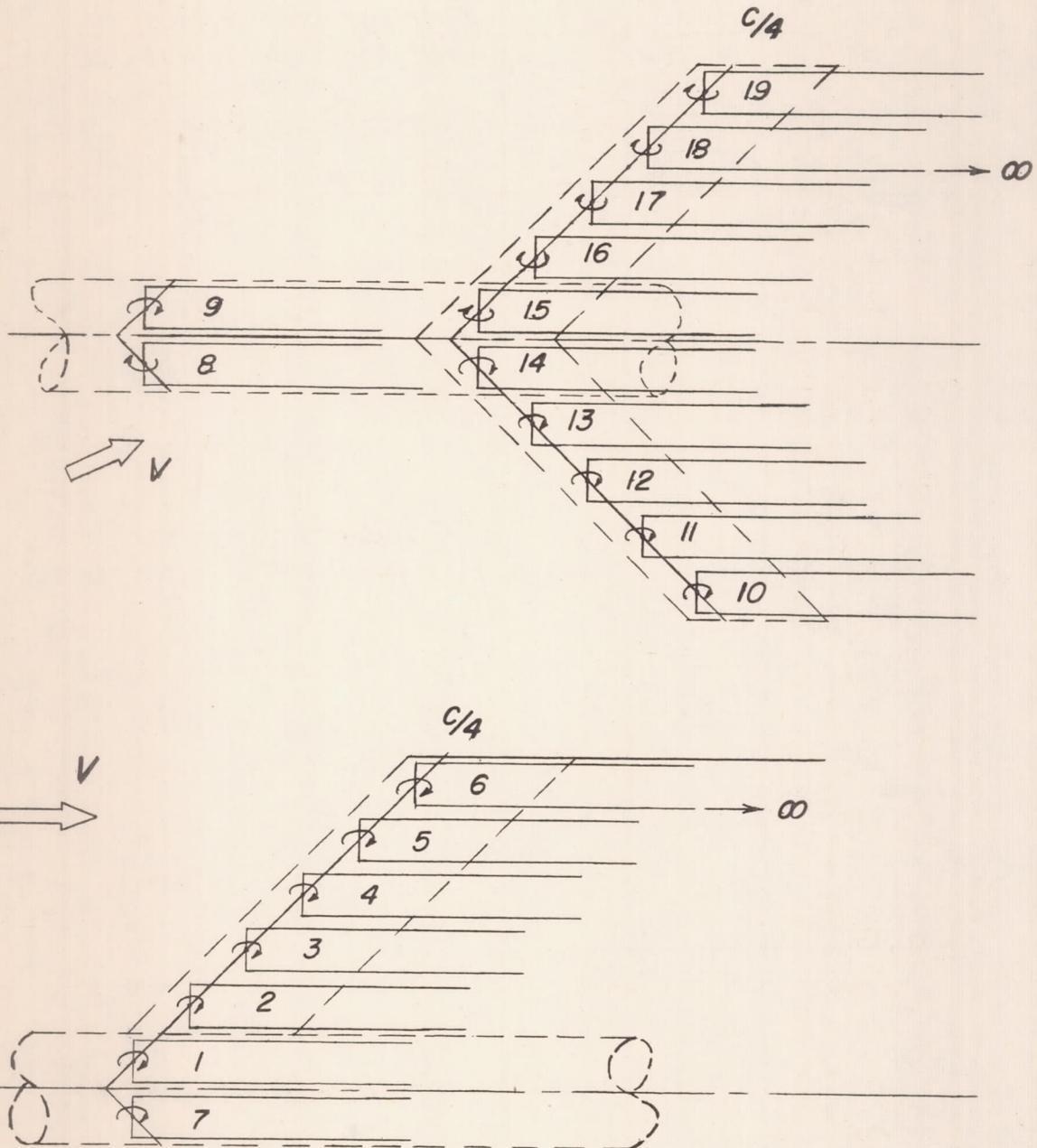
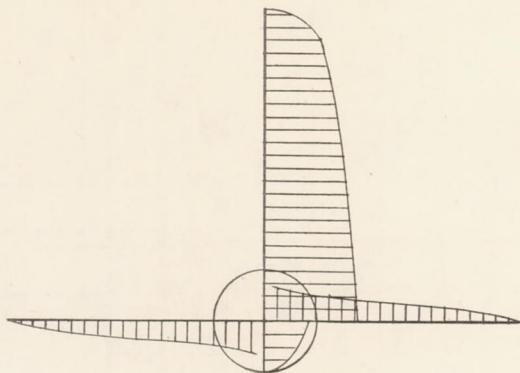
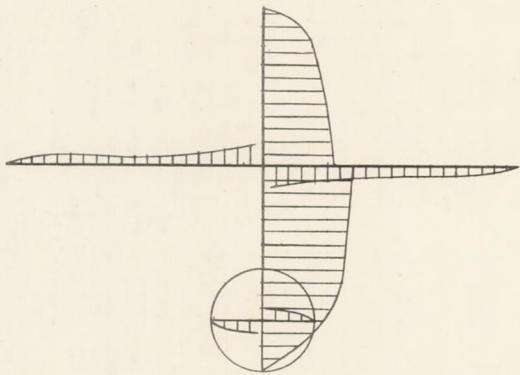


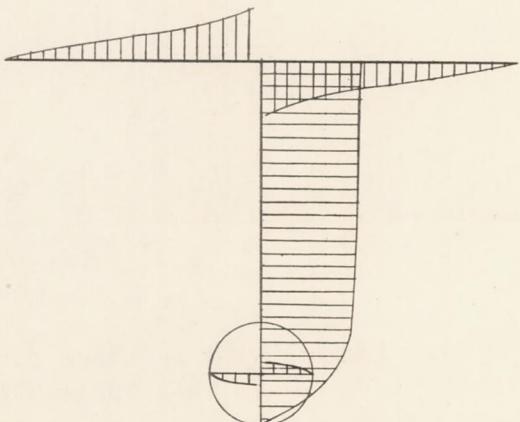
Figure 18.- Horseshoe-vortex representation of model with fuselage plus vertical tail with horizontal tail located at $1.0b_v$. (In application of the theory, adjacent trailing vortices are considered coincident.)



*Fuselage plus vertical tail
with horizontal tail at $0b_v$.*



*Fuselage plus vertical tail
with horizontal tail at $0.5b_v$.*



*Fuselage plus vertical tail
with horizontal tail at $1.0b_v$.*

Figure 19.- Typical calculated load distribution in sideslip on tail assemblies with horizontal tail at $0b_v$, $0.5b_v$, and $1.0b_v$.

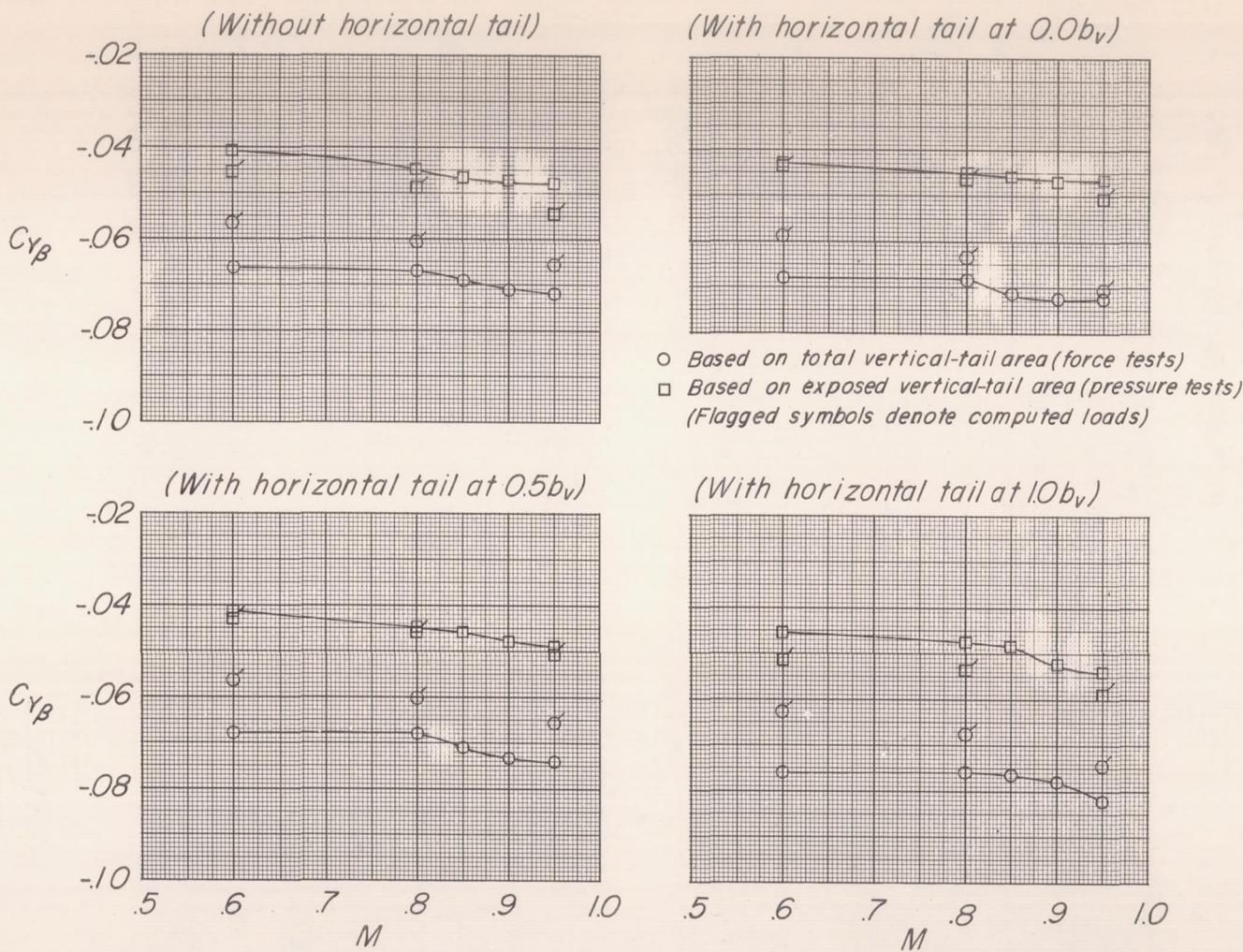


Figure 20.- Comparisons of the variations of $C_{Y\beta}$ with M as obtained from force tests, integrated pressure tests, and calculated theoretical span loadings. $\alpha = 0^\circ$.

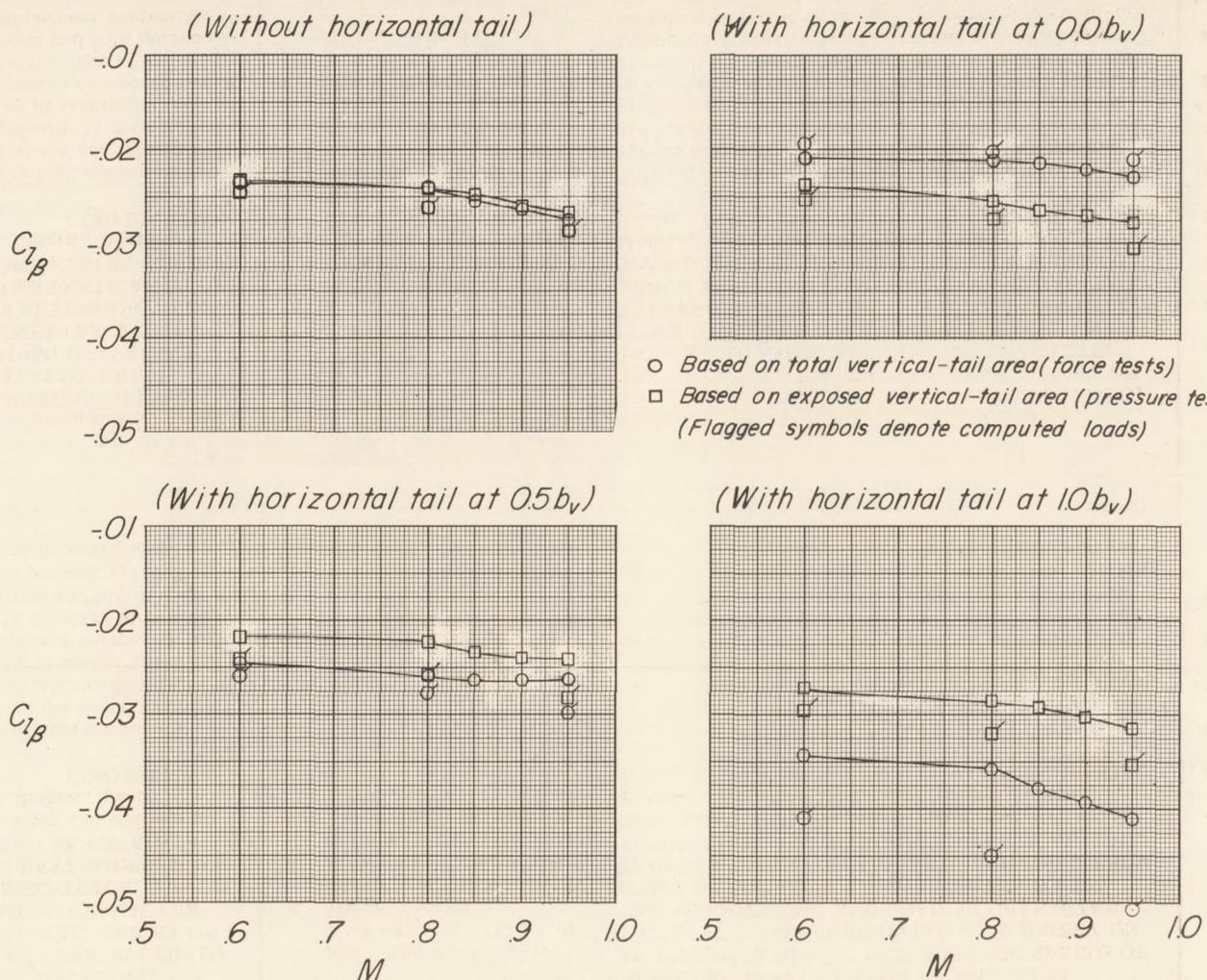


Figure 21.- Comparisons of the variations of $C_{l\beta}$ with M as obtained from force tests, integrated pressure tests, and calculated theoretical span loadings. $\alpha = 0^\circ$.

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